Vol. 46 OCTOBER 1920 No. 212

GENERAL LIBRARY
OCT 27 1920

United States Naval Institute Proceedings

The writers only are responsible for the contents of their respective articles

CONTENTS

	PAGE
American Production of Military High Explosives and Their Raw Materials.—Wright	1561
Radio Equipment on "NC" Seaplanes.—Lavender	1601
Policy—Its Relation to War and Its Bearing Upon Preparation for War.—Gill	1609
How the "Cushing" Towed in the "Murray."—Hains	1619
Building the Navy's Enlisted Personnel and Reestablishing its Morale and Spirit.—Thom	1627
Line of Position by Azimuth Observations.—Clements	1637
Mysteries of the Sea.—Morgan	1643
Discussion	1645
Secretary's Notes	1647
Professional Notes	1649
Notes on International Affairs	1696
Review of Books	1706
Information Index	1648

Copyright, 1920, by J. W. Conroy, Trustee for U. S. Naval Institute

Entered at the Post Office at Annapolis, Maryland, as Second Class Matter

WORLD'S ONLY MANUFACTURER

Moulded High Frequency—High Tension Insulators and Insulating Parts

INSULATORS, 1,000 TO 1,000,000 VOLTS

INSULATION "MADE IN AMERICA"

ELECTROSE

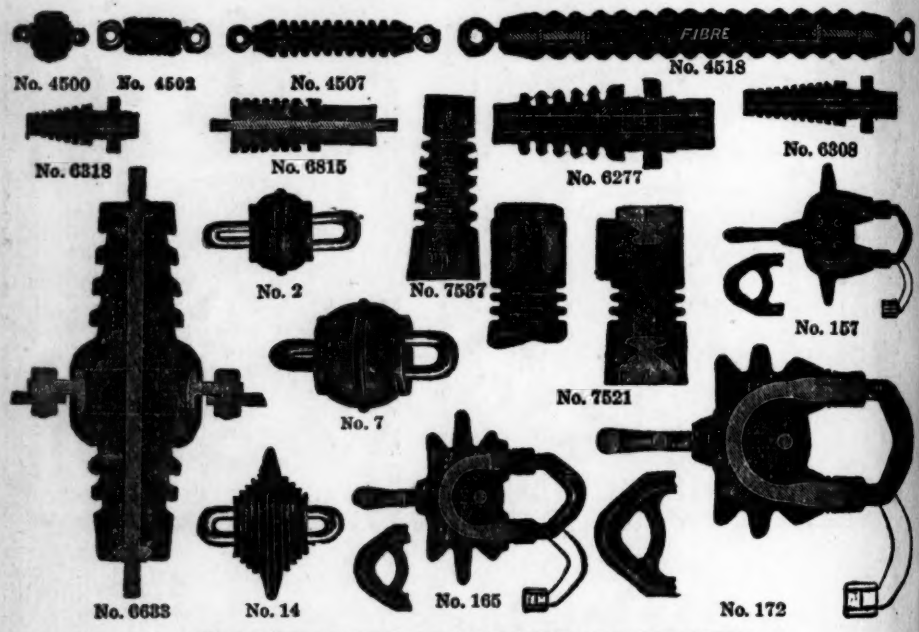
Louis Steinberger's Patents

INSULATION "MADE IN AMERICA"

"ELECTROSE" Insulators are standard with UNITED STATES NAVY and ARMY and WIRELESS TELEGRAPH and TELEPHONE COMPANIES.

"ELECTROSE" is made in a number of grades for various requirements, each grade possessing special characteristics.

"ELECTROSE" INSULATORS—BEST IN THE WORLD FOR HIGH FREQUENCY CURRENTS. POWER AND TRANSMISSION CIRCUITS



"ELECTROSE" STANDARD PRODUCTS

"Arcover" disk strain and suspension line insulators, "Safety Strain" insulators, Disk, Hook, Thimble and Rod type strain insulators, Spool and Bracket-Arm strain insulators, Pin type line insulators, Insulator pins, Roof, Barrier and Wall Bushings and Insulated Connectors, single and multi-part, plain and locking, water and gas tight, Bus-bar insulators, Insulating Supports and Pedestals, Arc Lamp Insulators, Insulating Knobs and Handles, Insulating Sheets, Tubes and Rods, etc., etc.

"Electrose" Railway Line Material:—"Safety Strain" Insulators, Brooklyn Strain Insulators, Insulated Turn-Buckles, Caps and Cones, "Ideal" Locking Caps and Cones, Insulated Bolts, Feed Wire Insulators, Third Rail Insulators, also special forms of Trolley Wire Suspension Insulators, etc., etc. Complete line always carried in stock.

Ignition Insulating Parts:—Distributor Blocks, Disks, Switch Bases, Spools, Brush Holders, Knobs, Handles, etc., etc.

"Electrose" insulation (certain grades) is recognized as the best obtainable for use in connection with insulating parts for ignition service for Automobiles, Aeroplanes, Motor Boats, etc.

Insulators and Insulating Parts and Devices of special sizes and forms, designed and made to order.

Sole Manufacturers

ELECTROSE M'F'G. CO.

66-82 Washington St. 27-37 York St.
66-76 Front St. 1-23 Flint St.

BROOKLYN, N. Y., AMERICA

Vol. 46, No. 10 October, 1920 Whole No. 212

United States Naval Institute

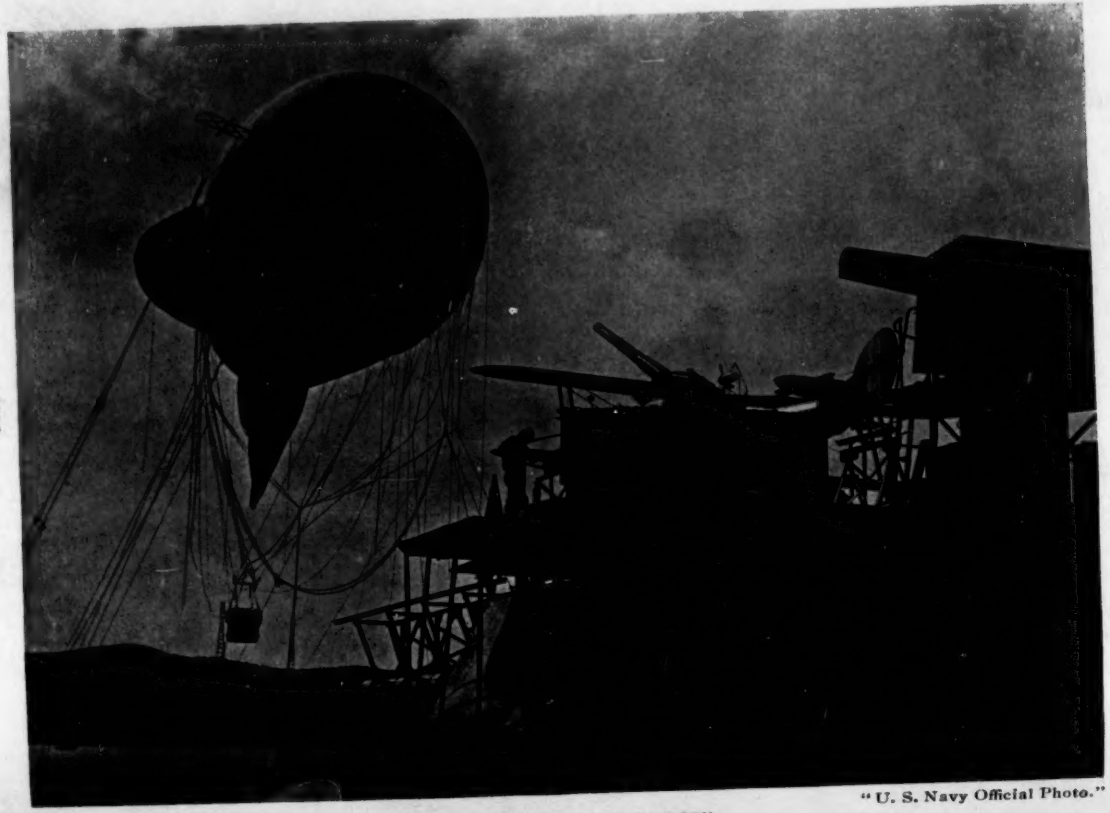
Proceedings

PUBLISHED MONTHLY
EDITED BY H. K. HEWITT

U. S. NAVAL INSTITUTE
ANNAPOLIS — MARYLAND

COPYRIGHT, 1920
BY J. W. CONROY
TRUSTEE FOR U. S. NAVAL INSTITUTE

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.



U. S. S. ARIZONA'S KITE BALLOON.

"U. S. Navy Official Photo."

UNITED STATES NAVAL INSTITUTE PROCEEDINGS

Vol. 46, No. 10 OCTOBER, 1920 Whole No. 212

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AMERICAN PRODUCTION OF MILITARY HIGH EXPLOSIVES AND THEIR RAW MATERIALS

By LIEUT. COMMANDER CARLETON H. WRIGHT, U. S. Navy

When H. M. S. *Hampshire* was sunk by a German mine on June 5, 1916, Germany rejoiced and gloom pervaded England, for Lord Kitchener, the man on whom Great Britain relied for guidance and leadership in the great struggle, went down with the ship. Now, however, it is generally recognized that his death at that time was a most fortunate occurrence for Great Britain and her allies, for Kitchener in his capacity of Secretary of State for War controlled in large part England's production of munitions, and his failure to grasp the fact that under the new conditions of warfare high explosives must be produced and supplied to the armies in the field in unprecedented amounts had already cost the British forces dearly.

Before the outbreak of the World War none of the combatants had realized how great the use of high explosives would be, but the Germans and also the French had been quick to grasp the significance of the changed conditions, and had taken prompt steps to raise their production of high explosives to the maximum. The British armies in the field also early realized the importance of adequate supplies of high explosive shell, but their appeals for increased supplies met with but little response, for Kitchener had received his training under far different conditions and he could not realize the revolutionary changes that had taken place.

U. S. S. ARIZONA'S KITE BALLOON.

After his death Great Britain joined the other combatants in bending every energy toward increasing the production of high explosives. In order to augment the supply the various belligerents developed on a large manufacturing basis many explosives which had hitherto not been deemed worthy of consideration, and maintained a continuous search for new sources of supply. One result of the continuously increasing demand was that the Allies soon turned to the United States for additional supplies.

Prior to that time this country had not been a large producer of explosives adapted to military use, or even of the raw materials for their manufacture. We did, however, have vast undeveloped resources, and the high prices offered by the Allies greatly stimulated production, both of the raw materials and of the manufactured explosives. Principally because of the great saving of valuable cargo space, the Allies encouraged the manufacture of the finished explosives in this country rather than having us furnish them with only the raw materials. This policy resulted in the building of many new explosives plants here and the rapid expansion of those already in existence.

Thus American production of military explosives rapidly increased and the way was being prepared so that, upon our entrance into the war, the upward trend of production was merely greatly accelerated to meet the requirements of our own military and naval forces, while still continuing to furnish vast supplies to the Allies. Some idea of our expansion as a supplier of military explosives may be had from the fact that in 1914 we produced just a little over twenty-one million pounds of smokeless powder and other military explosives, while at the time of the armistice our production of high explosives alone was at the rate of seven hundred and twenty-five million pounds per year and that of smokeless powder was even larger.

At the present time while the record of our war achievements is fresh in our minds it is well to consider in detail our production of military high explosives, with a view to learn what production we may expect in case of need in the future; where the material for the manufacture of our explosives is to be obtained; and wherein our potential domestic supplies of raw materials should be developed to render us, so far as possible, independent of imports.

HIGH EXPLOSIVES

An explosive has been defined by Marshall as "a solid or liquid substance or mixture of substances which is liable, on application of heat or of a blow to a small portion of the mass, to be converted in a very short interval of time into other more stable substances, principally gaseous, with the evolution of a considerable amount of heat."

Substances of this type which are used by our military forces may be divided into two general classes, "progressive explosives" and "high explosives." The former are the so-called powders used to propel the projectile from the gun in the firing of small arms and cannon. Their rate of combustion when used as propellants is very much lower than the rate of detonation of the high explosives. The latter, which constitute the bursting charge of projectiles, torpedoes, submarine mines, etc., are designed to explode only when in the vicinity of the enemy and consequently a high velocity of explosion is desired to insure complete fragmentation in the case of projectiles, or in the case of underwater explosions the maximum blow upon the hull of the enemy ship. Practically speaking, no substance is considered as a military high explosive unless the velocity of detonation is at least three thousand meters per second.

The properties of high explosives which are of chief interest are the power, sensitiveness, velocity of explosion, and stability.

High power is of the greatest importance, since it is desired to get the maximum explosive effect from a given weight of explosive. In the case of shell fillers the density of the material, as affecting the power possible from the limited space available, is also of importance.

The degree of sensitiveness must lie within certain definite limits, depending on the use to which the explosive is to be put. The substance must not be subject to premature detonation from shocks it may receive in service, yet it must not be so insensitive that there will be danger of failure to function under the conditions it will encounter in action.

Closely allied to the question of sensitiveness is the subject of detonators and boosters. A detonator is an explosive used to initiate an explosion in another substance. Since the material in the detonator is always more sensitive than that in the main

charge the size of the detonator is always kept at the minimum consistent with proper functioning.

Usually a booster or boosters of material more readily detonated than the main charge is interposed between the detonator and the charge. The detonator first explodes the booster and then the latter explodes the main charge. It has been shown that improper detonators and boosters may not only cause complete failure to explode, but also result in incomplete detonation or "low order" explosions in other cases where outward appearances indicate satisfactory functioning. The modern tendency is to adopt as main bursting charges substances which are more and more difficult to detonate, and consequently the use of efficient boosters and detonators is becoming of constantly increasing importance.

The velocity of explosion and the closely related property, "brisance" which has been defined as the rate of increase to maximum pressure, are of great importance, for upon them depend the proper fragmentation of projectiles and the intensity of the blow in under water explosions.

An explosive for military use must be stable under the worst conditions it will encounter in storage or in service. An unstable explosive cannot be considered, because it may either fail to function when desired or else will be a source of danger in handling. It might even exhibit both of these undesirable attributes.

THE INFLUENCE OF SUPPLY ON THE CHOICE OF EXPLOSIVES

There are a rather large number of substances known to the chemists of the world which would be almost equally satisfactory as military explosives. The nature of the raw materials, the available supply of these materials, and the cost of the finished substance vary within wide limits, however, and the two factors of available supply and cost must govern the choice of explosives when other factors are even approximately equal.

Considerations of national safety demand that so far as possible the materials for explosives manufacture be articles of domestic production. When the difference in cost in favor of an explosive made from imported materials is great there will be a strong tendency, particularly on the part of some legislators, to favor the cheaper material, but this does not alter the fact that the

choice of an explosive made from imported materials is fundamentally unsound if a satisfactory explosive can possibly be produced from domestic supplies.

In case it is necessary to import materials for explosives, the location of the world supply must be considered. When any choice is available, it is obviously best to select a material the supply of which is not controlled by any one nation. Likewise a supply which is not subject to interruption because of stoppage of ocean-borne commerce is highly to be desired.

In the World War we find frequent examples of the use of explosives which are rather unsatisfactory from a military point of view, but their use was forced upon the belligerents because the normal supplies of raw materials were interrupted, or because the available supplies of the raw materials required in the manufacture of the explosives they preferred were inadequate to supply their needs. Examples of such substitutions are the use of wood cellulose instead of cotton by the Germans and the use of nitroethane, trinitrocresol, trinitronaphthalene, etc., by the Allies.

The price of raw materials is of course regulated to a large extent by the age old law of supply and demand. Under the heading of supply must be considered not only the extent but also the location of the world's supply, for the Germans have shown in the dye industry, the potash industry, and the like, that a nation which is favored with natural advantages can, if she so desires, manipulate prices in such a manner as practically to prohibit the development of natural resources in other countries. A consideration of available resources must also take into account the purity of the materials as found, for the manufacture of explosives requires materials of a very high state of purity, and the cost of purification may eliminate from consideration the supply of material from certain sources.

Non-military demands for the same material required for the manufacture of a certain explosive, or for similar material, may favor or may operate against the adoption of that particular explosive. If the supply is insufficient to meet the normal demands the price will probably be prohibitively high. Upon the other hand, the demand from commercial sources may cause the development of new sources of supply, and thus favor the adoption of that explosive, particularly if the new sources of supply are domestic. Many of the materials most satisfactory for the

manufacture of explosives are by-products of other industrial processes, and naturally increased demand for the principal products of the process renders the by-products available in increased quantities and at attractive prices.

In any consideration of the sources of supply of raw materials it is essential that due attention be given to the fact that rapid progress is being made in the accumulation of chemical knowledge, and that new chemical processes are being developed which may practically revolutionize an industry. A most notable example of this as affecting explosives is the development of processes by which benzol may be used as the raw material for the manufacture of picric acid. The discovery of such a process vastly increased this country's possible production of high explosives.

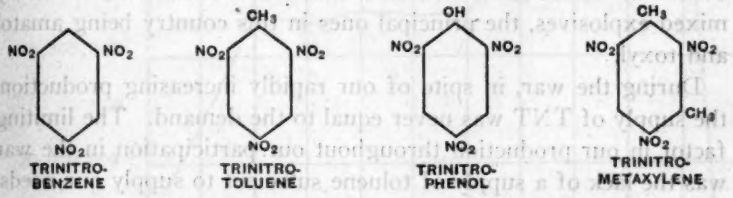
Even more revolutionary is the development of synthetic methods for the fixation of atmospheric nitrogen in Germany. It is worthy of note that as soon as these methods had been developed to a point of quantity production, rendering Germany independent of nitrates from Chili, she plunged the world into war. In marked contrast to this, it is known that at the time of the Agadir incident the German chemists informed the rulers of the empire that war could not be successfully waged until such synthetic processes had been developed, and consequently hostilities were at that time avoided.

THE PRINCIPAL HIGH EXPLOSIVES MANUFACTURED IN THE UNITED STATES

During the World War, as has previously been stated, large quantities of smokeless powder and high explosives for the Allies were manufactured in this country. In this paper only the production of high explosives will be discussed, for this is the branch of the explosives industry that made the most startling advances after we entered the war as a combatant. Since one of the objects of this article is to see what quantity of high explosives this country is capable of producing in case of emergency, the amounts of material made for the Allies will be included in the totals to be given hereafter. Although the Allies favored some explosives that have never been liked by our own forces, it is probable that in case of need in the future our production would follow the same general lines that it did in the late war.

The principal high explosives manufactured here for military use will be discussed separately:

1. *Nitrated Aromatic Compounds.*—Most of the modern high explosives are in whole or in part the product of the nitration of the aromatic compounds formed principally in the destructive distillation of bituminous coal. The most satisfactory of these explosives are the products of the trinitration of substances having a single benzene nucleus, *e. g.*, trinitrobenzene, trinitrotoluene, trinitrophenol, and trinitroxylene. It should be noted that in all of these the isomer most readily formed, and the one most stable of all those possible, is the one in which the three nitro groups are symmetrically arranged around the benzene ring:



Mono- and di-nitro bodies are ordinarily not in themselves satisfactory as high explosives, but they are used extensively in mixed commercial explosives, and to some extent in mixed military explosives, particularly in France and Germany. They have not been used to any important extent in military explosives in this country.

(*a*) *Trinitrobenzene.*—Trinitrobenzene is a very satisfactory high explosive, but because of the difficulty of nitrating benzene and the low yields obtained, its manufacture is so expensive as to be prohibitive. Toluene, phenol, and xylene are nitrated much more easily than benzene, as the presence of a substituent in the benzene ring facilitates the entrance of other substituents.

(*b*) *Trinitrotoluene.*—The widespread use of trinitrotoluene is indicated by the number of names under which it is known. The principal of these are TNT, trinitrotoluol, trotyl, tritolo, trinol, and trilite.

Although this explosive has only recently come into general use it has been waging a winning fight against picric acid for favor as a shell filler, and against guncotton for use in mines and torpedoes.

TNT is slightly less powerful than picric acid, but this disadvantage is more than outweighed by several distinct advantages. First of these is the fact that TNT, unlike picric acid, does not form sensitive salts when in contact with the heavy metals. Second is the fact that nitration of toluene is considerably easier than that of phenol, and the yield considerably nearer the amount that should theoretically be obtained. Still another advantage is the lower melting point of TNT, enabling it to be much more easily cast direct into shell cavities, etc.

TNT is used for bursting charges of projectiles, both by itself and mixed with other substances; for main charges of submarine mines, torpedoes, depth charges, and bombs; and it is also used in boosters. In addition it enters into the manufacture of many mixed explosives, the principal ones in this country being amatol and toxyl.

During the war, in spite of our rapidly increasing production, the supply of TNT was never equal to the demand. The limiting factor in our production throughout our participation in the war was the lack of a supply of toluene sufficient to supply our needs.

In Fig. 1 is shown our increasing production in 1918. For purposes of comparison the production in August, 1914, and April, 1917, is also given.

For the manufacture of one pound of TNT the following raw material is required: Toluene, 0.068 gal.; nitric acid (100 per cent), 1.11 pounds; sulphuric acid (100 per cent), 0.31 pounds. Besides these, alcohol and benzene are required in the purification by crystallization.

(c) *Picric Acid and Ammonium Picrate.*—Like TNT, trinitrophenol or picric acid is known under various names in different countries. The most common of these are P. A., lyddite, melinite, shimosite, and pertite.

Until recently picric acid or its ammonium salt were almost the only substances used by the nations of the world as a shell filler. Even now it is more extensively used for this purpose than any other material, and will no doubt continue to be for some time in the future, because the raw materials for the manufacture of picric acid—phenol and benzene—are available in great quantities.

Picric acid itself is a very satisfactory explosive for use in projectiles in practically all respects except one—that it forms

extremely sensitive salts when in contact with the heavy metals, especially lead. In recent years few serious accidents have occurred from this source because proper precautions have been taken to avoid any opportunity for the formation of such salts, but the necessity for care is always present.

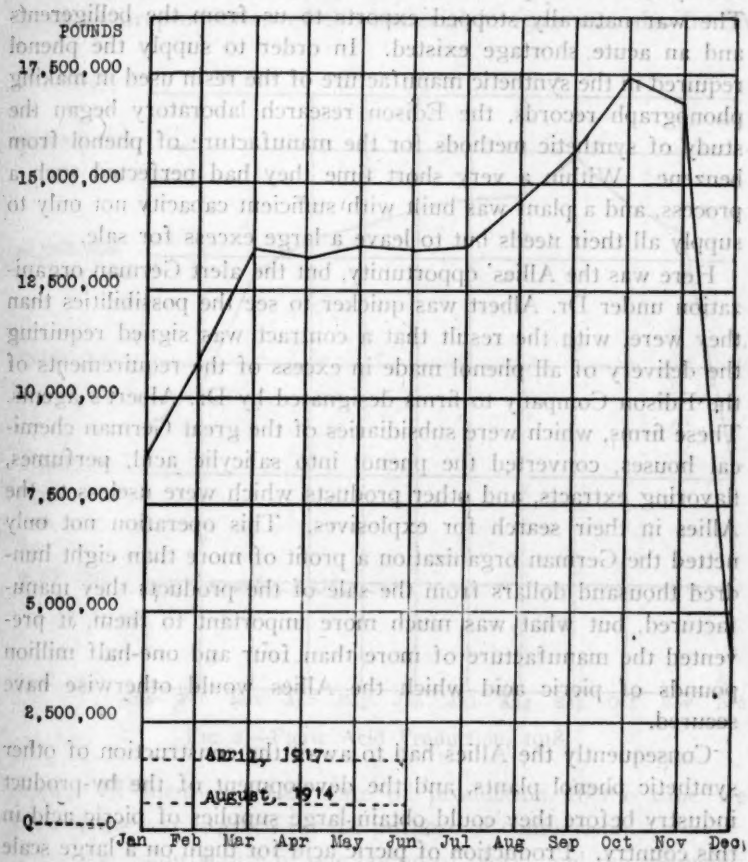


FIG. 1.—TNT Production, 1918.

Ammonium picrate is also a satisfactory explosive. The advantage in the use of ammonium picrate in place of picric acid is the reduction of the danger of the formation of metallic picrates.

Picric acid itself has never been adopted as a military high explosive in this country, but it has been in great demand in Europe, particularly on the part of France. When the Allies

turned to us for an augmentation of their supplies in 1915 the prospect of their receiving much assistance looked far from promising. To begin with, all picric acid was at that time made from phenol and we had never produced even enough phenol to satisfy our own requirements for the supply of commercial needs. The war naturally stopped exports to us from the belligerents and an acute shortage existed. In order to supply the phenol required in the synthetic manufacture of the resin used in making phonograph records, the Edison research laboratory began the study of synthetic methods for the manufacture of phenol from benzene. Within a very short time they had perfected such a process, and a plant was built with sufficient capacity not only to supply all their needs but to leave a large excess for sale.

Here was the Allies' opportunity, but the alert German organization under Dr. Albert was quicker to see the possibilities than they were, with the result that a contract was signed requiring the delivery of all phenol made in excess of the requirements of the Edison Company to firms designated by Dr. Albert's agents. These firms, which were subsidiaries of the great German chemical houses, converted the phenol into salicylic acid, perfumes, flavoring extracts, and other products which were useless to the Allies in their search for explosives. This operation not only netted the German organization a profit of more than eight hundred thousand dollars from the sale of the products they manufactured, but what was much more important to them, it prevented the manufacture of more than four and one-half million pounds of picric acid which the Allies would otherwise have secured.

Consequently the Allies had to await the construction of other synthetic phenol plants, and the development of the by-product industry before they could obtain large supplies of picric acid in this country. Production of picric acid for them on a large scale began in 1916, however, and we contributed important supplies both before and after we entered the war. In the later stages of the struggle production was not limited by shortage of raw material as only a small part of our total production of benzene went into the manufacture of picric acid.

Fig. 2 shows graphically our production of picric acid in 1918. Practically all of this was for delivery to the Allies, especially

the French, whose demands for this explosive seemed to be almost insatiable. The production of picric acid in the United States prior to the World War was negligible, with the little being made used largely as a dye.

In Fig. 3 is shown our production of ammonium picrate in 1918. Our production of this material in 1914 was also hardly

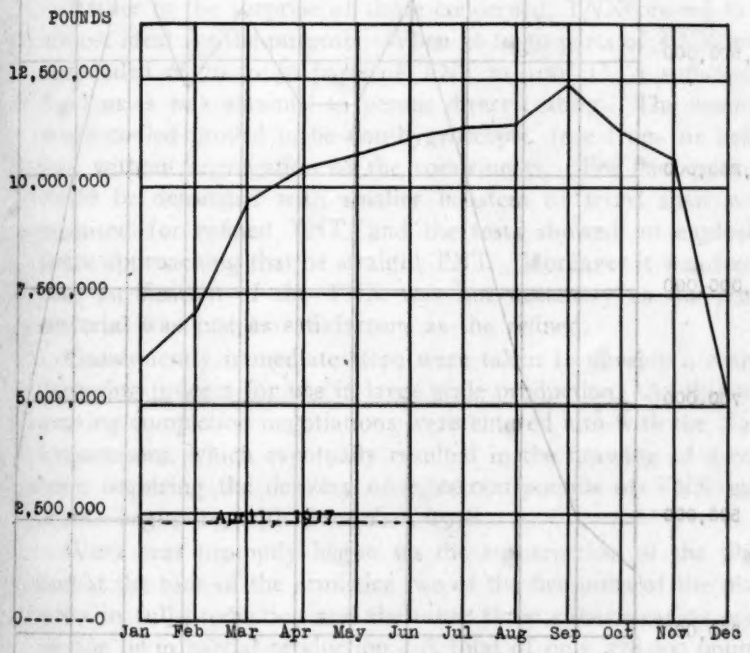


FIG. 2.—Picric Acid Production, 1918.

worthy of mention. Our rate of production at the time we entered the war is given for the purpose of comparison.

For the manufacture of one pound of picric acid the following material is required: Phenol, 0.566 pounds (the equivalent of 0.110 gal. benzene and 2.20 pounds of 100 per cent sulphuric acid); nitric acid (100 per cent), 1.34 pounds; sulphuric acid (100 per cent) 2.01 pounds.

For the manufacture of one pound of ammonium picrate the following is required: Picric acid 0.99 lb.; and ammonia 0.084 lb.

(d) *Trinitroxylene.*—From[1] its physical properties trinitroxylene or TNX would appear to be most unfavorable for use as a military high explosive. The melting point of the predominat-

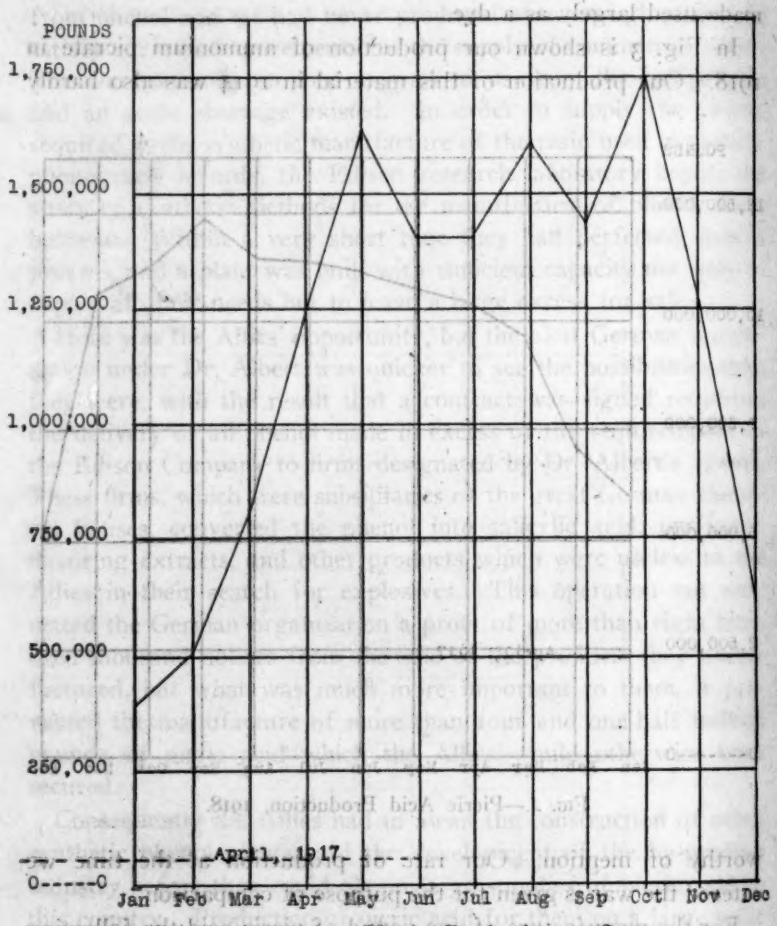


FIG. 3.—Ammonium Picrate Production, 1918.

ing isomer is very high, 182° C., making it impossible to load by direct casting. Moreover this compound is almost insoluble in other lower melting point nitro bodies at low temperatures, such as are preferable for casting, seemingly precluding the

[1] Marshall, Jour. Ind. and Chem. Eng., Mch., 1920.

casting of such a mixture. It has not more than 80 per cent the strength of TNT and it is much less sensitive to detonation.

The acute situation which developed in the TNT supply in the summer of 1917, however, made it necessary to consider the use even of material which appeared unfavorable. Under these conditions the du Pont Company began experiments with mixtures of TNX with TNT in cast charges.

Rather to the surprise of those concerned, TNX proved to be almost ideal for the purpose. When 30 to 50 parts of TNX were suspended in 70 to 50 parts of TNT at 100° C., a sufficiently fluid mass was obtained to permit direct casting. The castings when cooled proved to be non-hygroscopic, free from air holes, and without segregation of the components. The cast mixture could be detonated with smaller boosters of tetryl than were required for refined TNT, and the tests showed an explosive force approaching that of straight TNT. Moreover it was found that purification of the TNX was not necessary as the crude material was just as satisfactory as the refined.

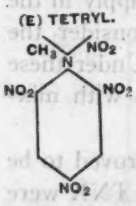
Consequently immediate steps were taken to develop a manufacturing process for use in large scale production. As this was nearing completion negotiations were entered into with the Navy Department, which eventually resulted in the drawing of a contract requiring the delivery of 2,500,000 pounds of TNX each month beginning with December, 1918.

Work was promptly begun on the construction of the plant and at the time of the armistice two of the five units of the plant were in full production and the other three either nearing completion or in partial production. A total of only 228,000 pounds of TNX was delivered, but it is certain that the large supply of this material which would have been available had the war lasted even a few months longer would have been most welcome.

Except in case of national emergency, the manufacture of TNX will not be carried on, for it is not so satisfactory an explosive as TNT, but the perfection of the manufacturing processes on a full scale is a distinct national asset, for we are now enabled, in case of future need, practically to extend our TNT supply by one-fifth.

Materials required for the manufacture of TNX are xylene (free from paraffines and naphthenes), nitric and sulphuric acids,

and sodium carbonate. The exact amounts can not be given, since the information belongs to the Du Pont Company.



Tetryl or trinitrophenylmethylnitramine is extensively used as a booster, as it has been found to be a most satisfactory substance for this purpose in the detonation of TNT and other nitro aromatic compounds. The high cost of its manufacture prevents its use as a main bursting charge, although it would otherwise be satisfactory for this purpose.

Because of its use being limited to the loading of boosters, the quantity of tetryl required is naturally much smaller than that of the other nitro aromatic compounds previously discussed.

Prior to the World War the amount of tetryl made in the United States was negligible. Before we entered the war considerable quantities were made for the Allies, but the really rapid increase in production was not made until 1918. Our production in that year is shown in Fig. 4.

For the manufacture of one pound of tetryl the following material is required: Dimethylaniline, 0.45 pounds; sulphuric acid (100 per cent), 4.47 pounds; nitric acid (100 per cent), 3.87 pounds.

NOTE.—One pound of dimethylaniline requires two pounds of aniline and 0.23 pound of methyl alcohol for its manufacture.

(f) *Other Nitro-Aromatic Compounds.*—Many other nitro-aromatic compounds are explosive substances, and some of them were used by European nations during the World War. Probably the most important of these are trinitrocresol, trinitroanisole, trinitronaphthalene, and tetranitroaniline, used principally by the French and Russians; and hexanitrodiphenylamine, used by the Germans in mixture with TNT as a bursting charge for torpedoes and mines. The first two of these have been tried out on a small scale in this country, but found unsatisfactory. The expense of manufacture of all except the nitrated naphthalenes has been very great in comparison with TNT, and none of them have sufficient advantage over TNT to displace it as a main bursting charge in this country. Just prior to the armistice the manufacture of tetranitroaniline was, however, begun in the United States. The plant and equipment were already in existence, having been built to manufacture this material for the Russians before we entered the war. As tests had shown it to be practically

as efficient as tetryl for boosters, manufacture was begun with the idea of augmenting our supply of material for boosters.

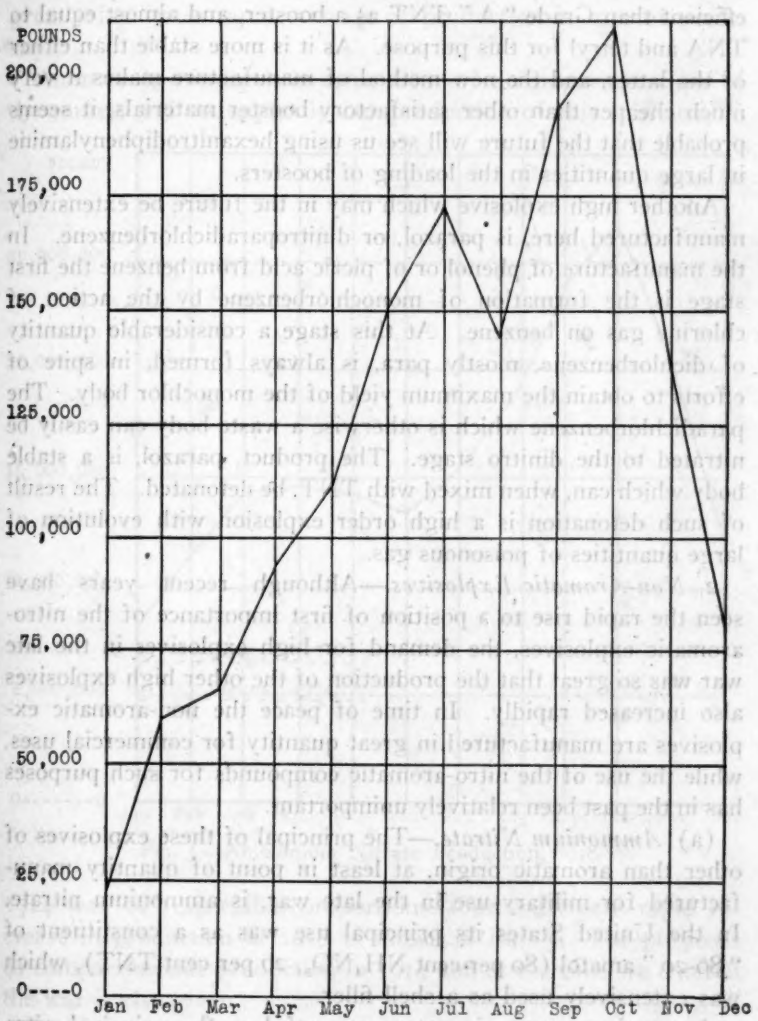


FIG. 4.—Tetryl Production, 1918.

About 8000 pounds were delivered, but none of this was used because of the cessation of hostilities.

Just recently the Du Pont Company has perfected a process for the manufacture of hexanitrodiphenylamine from dinitromono-

chlor benzene and analine, which gives a very high yield at low cost. Hexanitrodiphenylamine has been shown by test to be more efficient than Grade "A" TNT as a booster, and almost equal to TNA and tetryl for this purpose. As it is more stable than either of the latter, and the new method of manufacture makes it very much cheaper than other satisfactory booster materials, it seems probable that the future will see us using hexanitrodiphenylamine in large quantities in the loading of boosters.

Another high explosive which may in the future be extensively manufactured here, is parazol, or dinitroparadichlorbenzene. In the manufacture of phenol or of picric acid from benzene the first stage is the formation of monochlorbenzene by the action of chlorine gas on benzene. At this stage a considerable quantity of dichlorbenzene, mostly para, is always formed, in spite of efforts to obtain the maximum yield of the monochlor body. The paradichlorbenzene which is otherwise a waste body can easily be nitrated to the dinitro stage. The product, parazol, is a stable body which can, when mixed with TNT, be detonated. The result of such detonation is a high order explosion with evolution of large quantities of poisonous gas.

2. *Non-Aromatic Explosives.*—Although recent years have seen the rapid rise to a position of first importance of the nitro-aromatic explosives, the demand for high explosives in the late war was so great that the production of the other high explosives also increased rapidly. In time of peace the non-aromatic explosives are manufactured in great quantity for commercial uses, while the use of the nitro-aromatic compounds for such purposes has in the past been relatively unimportant.

(a) *Ammonium Nitrate.*—The principal of these explosives of other than aromatic origin, at least in point of quantity manufactured for military use in the late war, is ammonium nitrate. In the United States its principal use was as a constituent of "80-20" amatol (80 per cent NH_4NO_3, 20 per cent TNT), which was extensively used as a shell filler.

Ammonium nitrate is not so powerful as the principal nitro aromatic high explosives, is hygroscopic, and is prone to give low order explosions; but it appears to be the only shell filler that can be produced in sufficient amounts to supply our needs.

The cost is low because of the relative cheapness of the raw materials and the simplicity of the processes of manufacture. It

may be prepared by simply neutralizing nitric acid with ammonia, or by double decomposition between ammonium sulphate and sodium nitrate. The simplicity of the manufacturing operations greatly facilitates rapid increase of production in case of necessity.

Ammonium nitrate is a constituent of an important class of dynamites, and consequently our production of this substance in

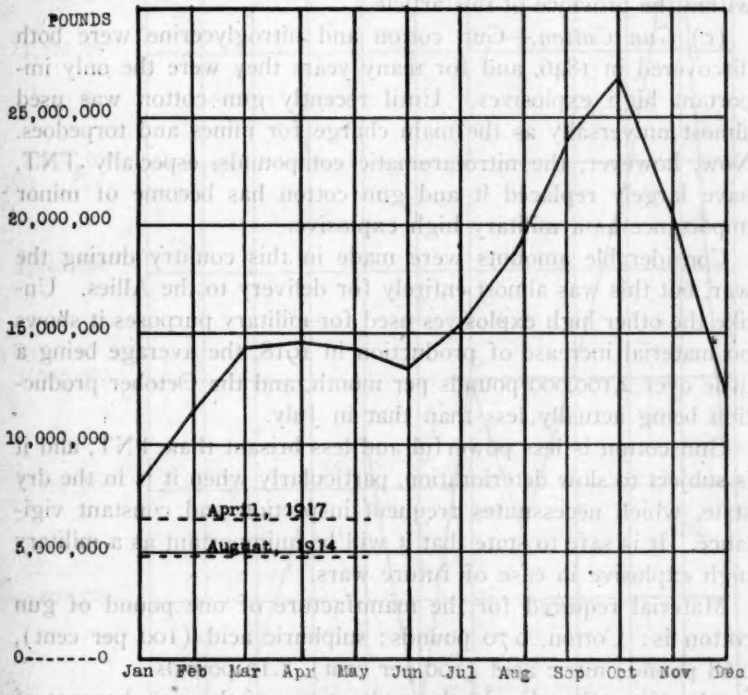


FIG. 5.—Ammonium Nitrate Production, 1918.

1914 was of respectable proportions. Our extremely rapid increase in production in 1918 is shown in Fig. 5. For purposes of comparison our production in 1914 and at the time we entered the war is also given.

The material required for the manufacture of one pound of ammonium nitrate by the neutralization process is: Ammonia, 0.23 pound; nitric acid (100 per cent), 0.813 pound.

(b) *Nitroglycerine.*—In time of peace nitrogylcerine is made in greater quantities than all other high explosives. In time of

war it is still of great national importance because of the extensive use of dynamite in the essential industries, but it is not adapted to military use and is not a constituent of any important military high explosives. It is however an important component of the so-called "two-base" (nitroglycerine-nitrocellulose) type of smokeless powders, such as cordite, which many other nations use as propellants. As such it does not, however, properly come within the province of this article.

(c) *Gun Cotton.*—Gun cotton and nitroglycerine were both discovered in 1846, and for many years they were the only important high explosives. Until recently gun cotton was used almost universally as the main charge for mines and torpedoes. Now, however, the nitro-aromatic compounds, especially TNT, have largely replaced it and gun cotton has become of minor importance as a military high explosive.

Considerable amounts were made in this country during the war, but this was almost entirely for delivery to the Allies. Unlike the other high explosives used for military purposes it shows no material increase of production in 1918, the average being a little over 2,100,000 pounds per month, and the October production being actually less than that in July.

Gun cotton is less powerful and less brisant than TNT, and it is subject to slow deterioration, particularly when it is in the dry state, which necessitates frequent inspection and constant vigilance. It is safe to state that it will be unimportant as a military high explosive in case of future wars.

Material required for the manufacture of one pound of gun cotton is: Cotton, 0.70 pounds; sulphuric acid (100 per cent), 0.68 pound; nitric acid (100 per cent), 1.12 pounds.

(d) *Nitro Starch.*—In the early stages of the war, because of the apparent shortage of TNT and NH_4NO_3 then existing, it was necessary to develop an explosive for filling grenades, trench mortar shell and drop bombs. To meet this need the Trojan Powder Co. developed a nitro-starch explosive which was adapted to this use. Nitro-starch explosives had been under investigation by other manufacturers for a number of years, but the difficulties incident to the manufacture and purification of nitro-starch had not previously been overcome.

The Trojan Powder Co., operating under a secret process, overcame these difficulties and all nitro starch explosives used

in the war were made by this company, although another nitro-starch explosive, manufactured by the Du Pont Co., was developed during the war and authorized for use.

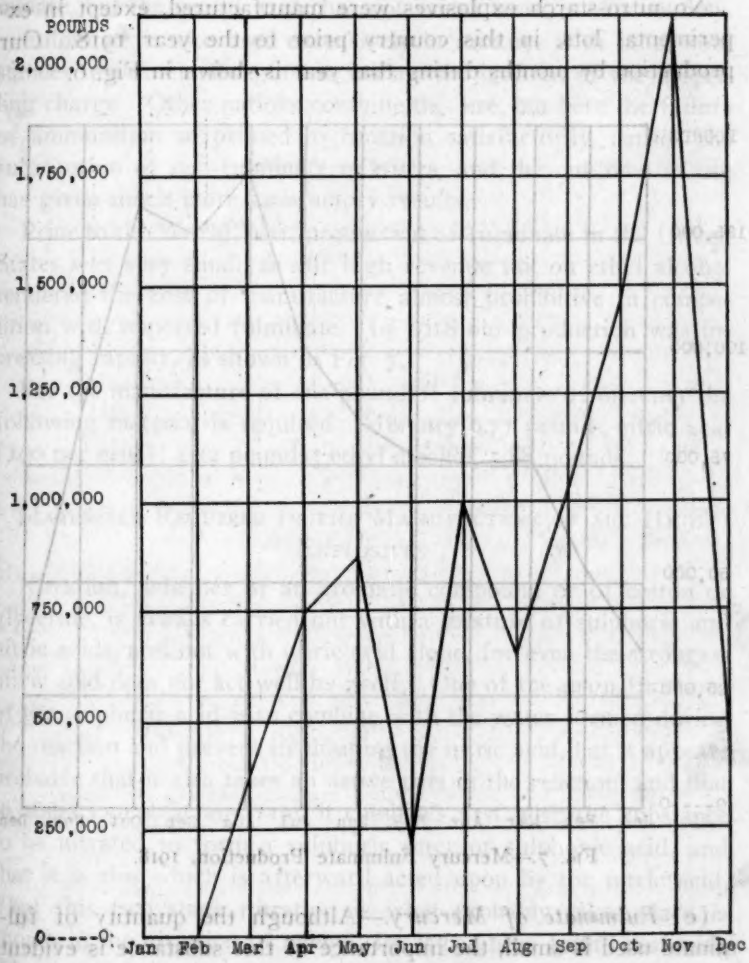


FIG. 6.—Trojan Powder Production, 1918.

Our country was the only one that used nitro-starch explosives during the war, but the results obtained in service were so satisfactory that there is reason to assume that if similar need were to arise in the future nitro-starch explosives would again be used by

us for filling grenades, and for similar uses. The cost of the raw materials is low, and the use of these materials does not interfere with the manufacture of other types of explosives.

No nitro-starch explosives were manufactured, except in experimental lots, in this country prior to the year 1918. Our production by months during that year is shown in Fig. 6.

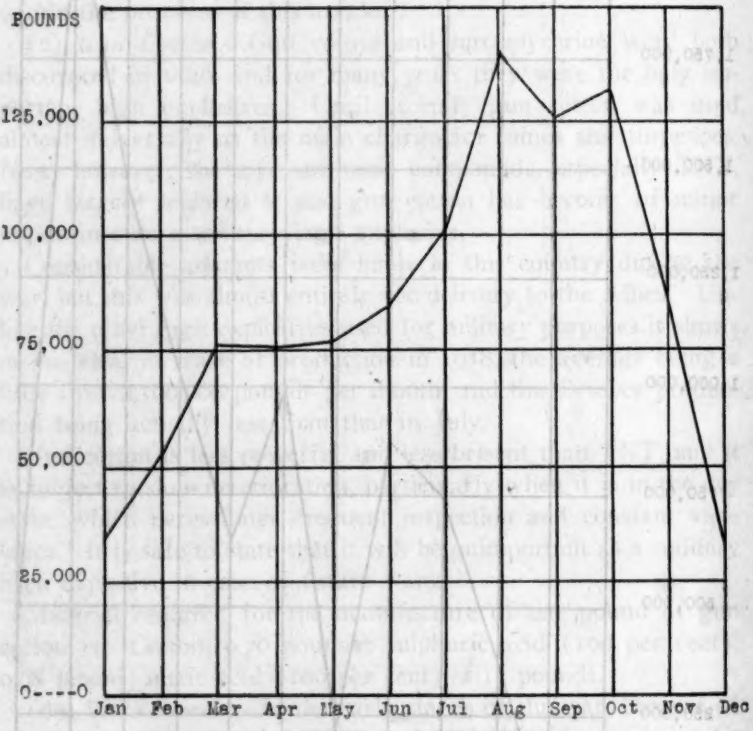


FIG. 7.—Mercury Fulminate Production, 1918.

(e) *Fulminate of Mercury.*—Although the quantity of fulminate used is small, the importance of this substance is evident from the fact that the detonation of every one of our high explosive shells, torpedoes, mines, and bombs is dependent upon the proper functioning of the fulminate in the detonator.

Nobel's discovery of the peculiar ability of fulminate to initiate a high order explosion in nitroglycerine was the first step in the development of high explosives. Since his time fulminate has

continued to hold its place as the most satisfactory initiator of high explosions that has ever been found. In some European nations lead azide, PbN_6, has recently been used to replace fulminate, but the use of azide has not found favor in this country.

Fulminate is also used extensively in mixture with other substances in primers for guns to initiate the ignition of the propelling charge. Other nations continue this use, but here the failure of ammunition so primed to function satisfactorily, caused the substitution of non-fulminate mixtures, and the one now in use has given much more satisfactory results.

Prior to the World War, production of fulminate in the United States was very small, as our high revenue tax on ethyl alcohol rendered the cost of manufacture almost prohibitive in competition with imported fulminate. In 1918 our production was increasing rapidly, as shown in Fig. 7.

For the manufacture of one pound of fulminate of mercury the following material is required: Mercury 0.77 pound; nitric acid (100 per cent), 4.42 pounds; ethyl alcohol, 5.88 pounds.

MATERIALS REQUIRED IN THE MANUFACTURE OF ALL HIGH EXPLOSIVES

Nitration,[1] whether of an aromatic compound or of cotton or glycerine, is always carried out with a mixture of sulphuric and nitric acids, and not with nitric acid alone, for even the strongest nitric acid does not act well by itself. One of the main functions of the sulphuric acid is to combine with the water formed during the reaction and prevent its diluting the nitric acid, but it appears probable that it also takes an active part in the reaction, and that to some extent at any rate, it combines first with the substance to be nitrated to form a sulphuric ester or sulphonic acid, and that it is this which is afterward acted upon by the nitric acid. That this two stage nitration is what probably takes place is shown in the nitration of phenol, for it has been found that with this material the best results are obtained by first acting on it with sulphuric acid with the formation of phenol sulphonic acid, and then as a second stage of the process to act upon the latter with nitric or mixed acids, when picric acid results.

[1] Explosives, A. Marshall, 1917.

In all nitration the use of sulphuric acid makes the nitration not only more complete, but also much more rapid.

In the process of nitration important amounts of acid are consumed. The quantities of acid previously stated as required in the manufacture of the various explosives are the average figures from our explosives plants in 1917 and 1918. The consumption of acids in the manufacture of explosives in most foreign countries is even higher, a French official estimate of their requirements being "sulphuric acid 4 to 5 times the weight of the explosive, nitric acid 2 to 3 times the weight of the explosive."

1. *Sulphuric Acid.*—Sulphuric acid is made from pyrites, zinc blende, or sulphur by the "chamber process" or the "contact process." In both of these processes the first stage is to burn the sulphur or sulphur-containing ore in an excess of air, converting the sulphur to sulphur dioxide. It is then necessary to make the sulphur dioxide combine with a further quantity of oxygen to form sulphur trioxide, which when combined with one molecule of water forms sulphuric acid.

In the chamber process the extra oxygen is added by mixing a small quantity of oxides of nitrogen, added in the form of spray or with a steam jet, with the sulphur dioxide.

In the contact process the sulphur dioxide and a considerable excess of oxygen are passed over a platinum catalyzer, which brings about the conversion to sulphur trioxide.

A disadvantage of the chamber process as a means of manufacturing sulphuric acid in time of war is the fact that it uses up considerable quantities of nitric acid, which can not well be spared from the supply available for nitration in the manufacture of explosives. In addition, the contact process is the one best adapted to the production of pure concentrated acid and oleum, as required for the manufacture of explosives. For this reason most of the large explosives plants now make their acid by the contact process.

Before the war a large part of the sulphuric acid manufactured in this country was made from pyrites imported from Spain. During the war the difficulties of transatlantic transportation greatly reduced these imports and our own resources were rapidly developed to take care of the market formerly supplied by Spain, as well as of the steadily increasing demand from the Allies and from our own industries. The principal increases in production

were from the pyrites mines of Virginia and the sulphur deposits of Louisiana and Texas. The field in the latter two states, made

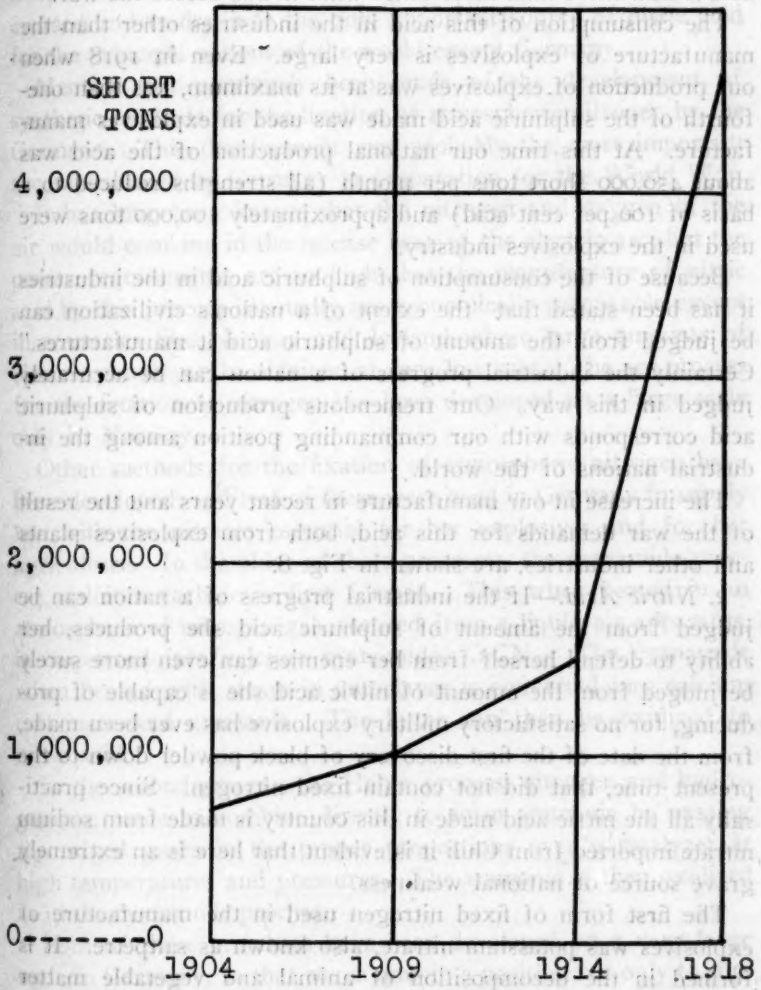


FIG. 8.—Sulphuric Acid Production. (Reduced to 100 Per Cent Acid Basis.)

workable through the ingenuity of an American engineer, now supplies the raw material used in the manufacture of most of the high grade acid made in this country. Our supplies of sulphur

are much larger than those of any other nation, and our plant facilities have been increased until our possible production of the acid is now more than three times what it was before the war.

The consumption of this acid in the industries other than the manufacture of explosives is very large. Even in 1918 when our production of explosives was at its maximum, less than one-fourth of the sulphuric acid made was used in explosives manufacture. At this time our national production of the acid was about 450,000 short tons per month (all strengths reduced to a basis of 100 per cent acid) and approximately 100,000 tons were used in the explosives industry.

Because of the consumption of sulphuric acid in the industries it has been stated that "the extent of a nation's civilization can be judged from the amount of sulphuric acid it manufactures." Certainly the industrial progress of a nation can be accurately judged in this way. Our tremendous production of sulphuric acid corresponds with our commanding position among the industrial nations of the world.

The increase in our manufacture in recent years and the result of the war demands for this acid, both from explosives plants and other industries, are shown in Fig. 8.

2. *Nitric Acid.*—If the industrial progress of a nation can be judged from the amount of sulphuric acid she produces, her ability to defend herself from her enemies can even more surely be judged from the amount of nitric acid she is capable of producing, for no satisfactory military explosive has ever been made, from the date of the first discovery of black powder down to the present time, that did not contain fixed nitrogen. Since practically all the nitric acid made in this country is made from sodium nitrate imported from Chili it is evident that here is an extremely grave source of national weakness.

The first form of fixed nitrogen used in the manufacture of explosives was potassium nitrate, also known as saltpetre. It is formed in the decomposition of animal and vegetable matter under favorable conditions. Deposits of saltpetre are formed in considerable quantities only in thickly populated countries which are sufficiently warm to accelerate the decomposition, and which have a long dry season during which the deposit can collect without being washed away. Of course these conditions are not found anywhere in the United States.

True saltpetre remained the chief source of fixed nitrogen until about 1850 when sodium nitrate (Chili saltpetre) began to take its place. The consumption of Chili saltpetre has steadily increased and to-day it is the only important source of nitric acid for the principal nations of the world except Germany.

Mention has previously been made of the development of synthetic methods for the fixation of atmospheric nitrogen by the Germans. This development was probably the most important accomplishment of Germany in preparation for the World War.

It has long been known that the nitrogen and oxygen of the air would combine in the intense heat of the electric arc, but the power requirements are so high that the manufacture of nitric acid by this process is usually not economically practicable except in countries like Norway and Iceland where large amounts of electric power can be obtained at very low cost. The arc process for the fixation of nitrogen has been developed on a large scale only in Norway.

Other methods for the fixation of atmospheric nitrogen have been developed, and two of these were used in Germany to supply her with the nitrates essential for her explosives and for her agriculture. In the older of these processes, the cyanamide process, calcium carbide is first formed. This when heated in an atmosphere of nitrogen gas, secured from a liquid air apparatus, is converted into calcium cyanamide, $CaCN_2$. The cyanamide when heated with steam in autoclaves is converted into calcium carbonate and ammonia. The latter can then be oxidized to nitric acid.

In the second process, the Haber process, nitrogen and hydrogen are made to combine directly to form ammonia by passing the mixed gases in the proper proportions over a catalyzer at high temperatures and pressures. The ammonia is then oxidized as in the cyanamide process.

Both of these processes have been developed on a very large scale in Germany, so that she is now in a position not only to supply her own needs, but also to sell a large surplus to other countries in competition with Chili saltpetre. If permitted, Germany will undoubtedly resort to her old methods of price cutting so as to prevent the development of synthetic nitrate manufacture in other countries where investigation of the subject is now under way.

In the United States more than one hundred million dollars was spent in the construction of nitrogen fixation plants during the war, but the processes have not yet been perfected on the large scale attempted. Since the armistice almost no advance has been made in the way of production, and progress is now practically at a standstill awaiting a decision from Congress as to the disposition to be made of the plants. In the meantime private capital hesitates to enter the field because of doubt as to the future of the government plants, and question of the ability to compete with imports of nitrates from the natural deposits in Chili and from the fixation plants already well established in Germany.

The seriousness of our dependence upon imports is evident from the fact that in 1918 we imported 60 per cent of all the sodium nitrate produced in Chili. Our 1919 explosives program would have required the consumption of 2,246,654 long tons of sodium nitrate or its equivalent, and this is only 600,000 tons less than the maximum annual production from the Chilean fields. Assuming that we could have obtained the amount we would have required from this source, it is apparent that the Allies, who are also dependent upon this source of supply would have been in desperate straits. Our own agricultural interests would also have suffered severely from the shortage of nitrates for use as fertilizers.

It is evident that it is necessary as a matter of national safety to establish the nitrogen fixation industry in this country so that in case of future need we will not be dependent upon imports of a material which is an absolute essential in the manufacture of explosives for our fighting forces, and of fertilizers which are essential if the people of this country are to be clothed and fed.

Another potential source of nitric acid is the by-product ammonia produced in our gas works and coking plants. The by-product coke ovens now constructed have a working capacity of 179,320,000 pounds of ammonia annually. If all of this were to be oxidized to nitric acid, 382,564 short tons of acid would be produced. This is the equivalent of 535,590 long tons of sodium nitrate. Of course all the ammonia could not be spared for such conversion to nitric acid, because of the extensive use of ammonia in the essential industries, and in the manufacture of ammonium nitrate and ammonium picrate.

The rapid increase in the production of nitric acid in 1918 to supply the demand in the manufacture of explosives is shown in Fig. 9. In contrast with sulphuric acid, nitric acid is used in comparatively small amount in other industries. In 1918 more

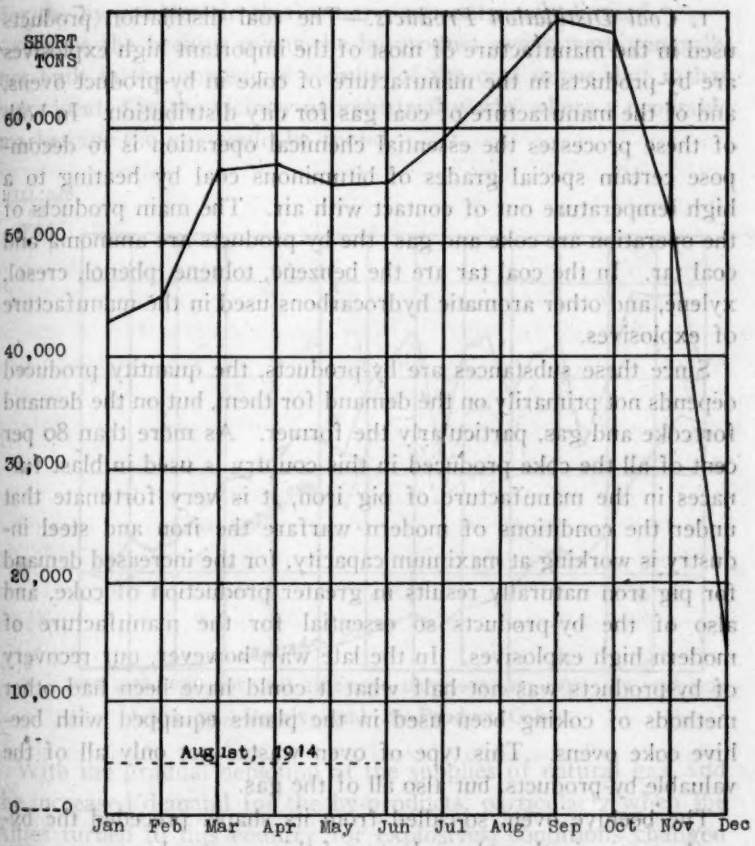


FIG. 9.—Nitric Acid Production, 1918.

than 95 per cent of the total consumption was in the manufacture of explosives.

For the manufacture of one pound of 100 per cent nitric acid from sodium nitrate the following material is required: Sodium nitrate, 1.57 pounds; sulphuric acid (100 per cent), 1.46 pounds. Some manufacturers use much more nitrate than this, but the

above figure represents the average result in efficiently operated American plants.

OTHER MATERIALS REQUIRED FOR ONE OR MORE OF THE IMPORTANT HIGH EXPLOSIVES

1. *Coal Distillation Products.*—The coal distillation products used in the manufacture of most of the important high explosives are by-products in the manufacture of coke in by-product ovens, and of the manufacture of coal gas for city distribution. In both of these processes the essential chemical operation is to decompose certain special grades of bituminous coal by heating to a high temperature out of contact with air. The main products of the operation are coke and gas; the by-products are ammonia and coal tar. In the coal tar are the benzene, toluene, phenol, cresol, xylene, and other aromatic hydrocarbons used in the manufacture of explosives.

Since these substances are by-products, the quantity produced depends not primarily on the demand for them, but on the demand for coke and gas, particularly the former. As more than 80 per cent of all the coke produced in this country is used in blast furnaces in the manufacture of pig iron, it is very fortunate that under the conditions of modern warfare the iron and steel industry is working at maximum capacity, for the increased demand for pig iron naturally results in greater production of coke, and also of the by-products so essential for the manufacture of modern high explosives. In the late war, however, our recovery of by-products was not half what it could have been had other methods of coking been used in the plants equipped with beehive coke ovens. This type of oven wastes not only all of the valuable by-products, but also all of the gas.

The beehive oven, so-called from its shape, preceded the by-product oven in the coke industry of this country by many years, and occupied a commanding position with a production of more than twelve million tons of coke per year when the first by-product oven was built in 1893. The number of by-product ovens increased slowly, and it was not until 1912 that the by-product production of coke equalled that obtained from the beehive ovens in 1893. In the meantime the production of the latter had more than trebled.

Among the reasons for the beehive ovens retaining the lead in production were: the fact that it was first in the field; that large supplies of natural gas were available near the principal fields, making the manufacture of coal gas unprofitable; that the supply of coal was abundant and very cheap; and that the market for the by-products in this country was extremely limited.

Unlike the beehive ovens the by-product ovens were generally not built in the immediate vicinity of the coal mines, but rather were located in the vicinity of industrial works where a profitable market for the gas could be found.

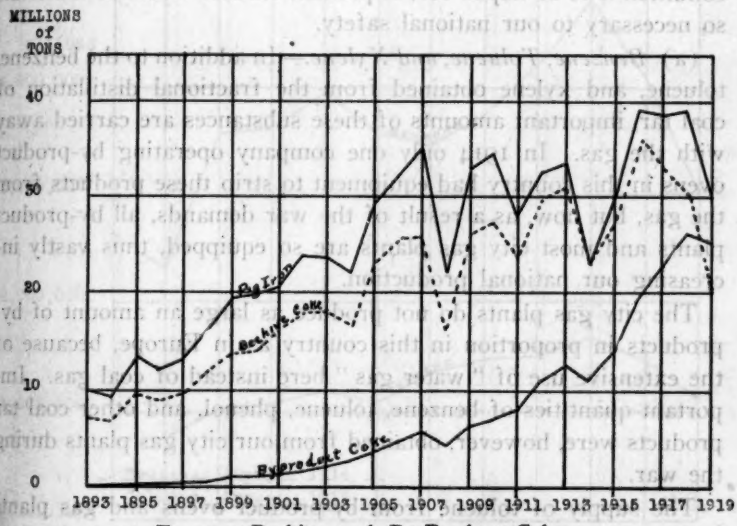


FIG. 10.—Beehive and By-Product Coke.

With the gradual depletion of the supplies of natural gas, and the increased demand for the by-products, particularly when the Allies turned to this country for explosives, conditions changed even in the vicinity of the coal fields, and the construction of by-product ovens in large numbers was energetically begun. The change to this type of oven has been so rapid that in 1919, for the first time in history, the output of coke from our by-product ovens was greater than that from the beehive type.

The growth of the two types of ovens in the coke industry, and the production of pig iron corresponding is shown in Fig. 10. It will be noted that the production of beehive coke varies the

more markedly from year to year, and is the more sensitive to variations in our pig iron production. Although the beehive capacity is still the greater, the tendency is for the by-product ovens to work at nearly full capacity to carry the normal load, and for the beehive type to be called upon only for the "peak load." It seems but natural to suppose that future increase of capacity, and necessary replacement of old ovens will be accomplished by the construction of more by-product ovens, and that in the not very distant future the beehive type will cease to be an important producer of coke in this country. Certainly this condition is to be hoped for, to prevent further waste of materials so necessary to our national safety.

(a) *Benzene, Toluene, and Xylene.*—In addition to the benzene, toluene, and xylene obtained from the fractional distillation of coal tar, important amounts of these substances are carried away with the gas. In 1914 only one company operating by-product ovens in this country had equipment to strip these products from the gas, but now, as a result of the war demands, all by-product plants and most city gas plants are so equipped, thus vastly increasing our national production.

The city gas plants do not produce as large an amount of by-products in proportion in this country as in Europe, because of the extensive use of "water gas" here instead of coal gas. Important quantities of benzene, toluene, phenol, and other coal tar products were, however, obtained from our city gas plants during the war.

The supply of toluene from by-product ovens and gas plants was never sufficient to supply the demand for TNT, and consequently other possible sources of supply were diligently investigated.

The first and most important of the processes to obtain toluene from other sources than coal distillation was that developed by the General Petroleum Company of Los Angeles, California. In their process a yield of six per cent of toluene was secured from a distillate from certain California bituminous base petroleums, by subjecting this distillate to high temperature while under great pressure. Two plants were built to operate on this principle. Their combined rated capacity was 3,000,000 pounds of toluene monthly.

Two other cracking processes, one known as the "Rittman" process and the other known as the "Hall" process, were investigated and production of toluene from solvent naphtha was conducted on a small scale by each of these processes while hostilities lasted.

With the present low price of toluene it is extremely doubtful that it would be profitable to make it by any of these cracking processes, but the methods are now available as a means of increasing our supply if the need ever again arises.

FIG. 11.—Benzene and Toluene Production, 1918.

The great increase in our production of benzene and toluene from all sources is shown in Fig. 11. This increase was brought about mostly by the rapid increase in the number of our by-product ovens and the installation of apparatus for the scrubbing of gas. The maximum possible recovery of xylene has never been made, because this material was not used in the manufacture of explosives until the closing days of the war. It is estimated that we can count on a production of xylene about one-fifth as great as that of toluene.

(b) *Phenol.*—The coal tar acids, phenol and cresol, are present in much larger amounts in the tar from coal gas works than in that from by-product ovens or water gas plants. In Europe, and especially in England, a much larger proportion of coal gas tar is available than in the United States, because of the lesser use of

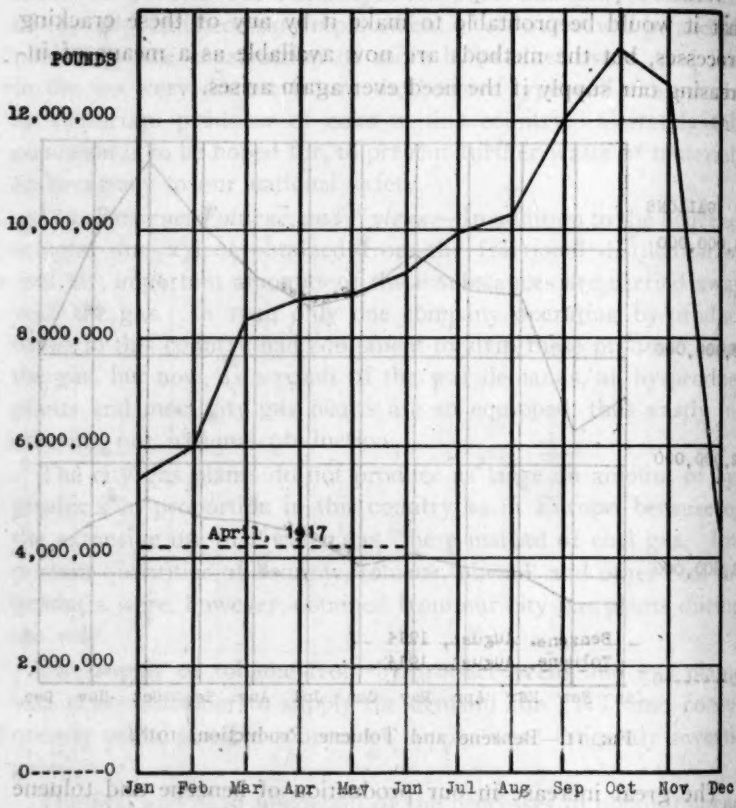


FIG. 12.—Phenol Production, 1918.

water gas there in illuminating gas plants. This accounts for the fact that natural phenol to the extent of about 8,000,000 pounds annually was regularly imported from Europe before the war. As has been previously mentioned, the cutting off of our imports combined with the great demand for picric acid caused the rapid development of synthetic manufacture of phenol from benzene. Our production of phenol from coal tar also naturally increased

with the expansion of the by-product industry, but during the war by far the largest part of our phenol was made synthetically. Our production of phenol in 1918 is shown graphically in Fig. 12.

(c) *Ammonia.*—The distillation of coal is now the only important source of ammonia. Naturally the expansion of the by-product coking industry in recent years resulted in greatly increased production of ammonia. Our rapidly rising production of ammonia in 1918 is shown in Fig. 13.

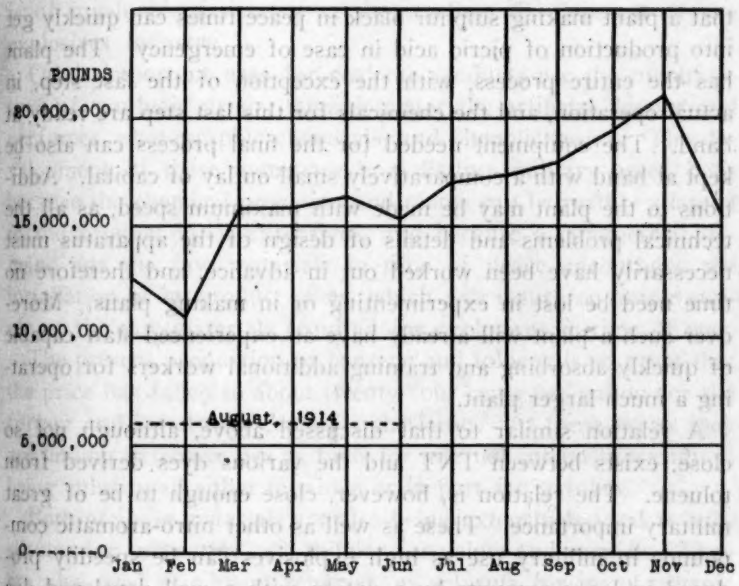


FIG. 13.—Ammonia Production, 1918.

(d) *Commercial Uses for the Coal Distillation By-Products.*—It is evident that these so-called coal tar products will not be available in sufficient quantities to satisfy our needs for explosives in case of future war unless the demand for them in time of peace is sufficiently great to make it profitable to operate plants for their recovery. It is therefore profitable to survey the uses to which they are now put. The first class of compounds that generally occurs to the mind in connection with coal tar products is dyes. The close relation between dyes, explosives, and poison

[a] Census Dyes and Coal Tar Chemicals, Fed. Trade Com., 1918.

gases is of the greatest importance from the military point of view, because the dye factory can be quickly converted into an explosive or poison gas factory in an emergency, using the same staff, materials, and apparatus, with only slight modifications which are easily and quickly made.

The relation between picric acid and sulphur black, the dye ranking first in point of quantity production in this country, is particularly intimate, the manufacture of these two products from benzene being identical until the last step. It is evident that a plant making sulphur black in peace times can quickly get into production of picric acid in case of emergency. The plant has the entire process, with the exception of the last step, in actual operation, and the chemicals for this last step are ready at hand. The equipment needed for the final process can also be kept at hand with a comparatively small outlay of capital. Additions to the plant may be made with maximum speed, as all the technical problems and details of design of the apparatus must necessarily have been worked out in advance, and therefore no time need be lost in experimenting or in making plans. Moreover such a plant will already have an experienced staff capable of quickly absorbing and training additional workers for operating a much larger plant.

A relation similar to that discussed above, although not so close, exists between TNT and the various dyes derived from toluene. The relation is, however, close enough to be of great military importance. These as well as other nitro-aromatic compounds in military use as high explosives can be speedily produced in large amounts by a nation with a well developed dye industry, but only with much more difficulty and considerable loss of time by a nation without a dye industry. The propellant, fulminate, and dynamite branches of the explosives industry do not have as close a relationship to the dye industry as does that branch dealing with the nitro-aromatic compounds.

It is well known that these military considerations have received great weight in the development of the German dye industry and that the relatively small amount of equipment required for the conversion of their dye factories into explosives plants was ready at hand.

In the United States to-day certain chemical plants which were erected during the war to manufacture explosives and poison

gases have already been converted into dye or intermediate plants, or to other peace-time purposes. This procedure in America is a complete reversal of the procedure in Germany at the outbreak of the war.

Another important point to be considered in connection with the relationship of the dye industry of a nation to her potential production of high explosives is the fact that the dye industry encourages the researches of a large number of skilled organic chemists with the resultant knowledge of organic compounds that is of invaluable assistance in the wartime development of the explosives industry.

Other important uses for coal tar products are the manufacture of synthetic drugs, tanning materials, artificial flavors and perfumes, photographic chemicals, and phenolic resins. The development of these industries is a distinct military asset, both because the chemical processes and plants can be readily adapted to the production of explosives, and because a commercial demand for the raw materials in time of peace encourages the installation of by-product ovens which will insure an ample supply of the raw materials required for explosives in time of war.

The present production of benzene and toluene is so great that the price has fallen to about twenty-four cents per gallon for the former and twenty-six cents for the latter. At these prices they are finding extensive use as fuels for internal combustion engines being substituted either in whole or in part for gasoline.

Both of these materials are also being extensively used as substitutes for turpentine as a thinner for paints and varnish. They are also used as a paint remover, as solvents for many organic substances, particularly rubber, and as raw material in the manufacture of certain varieties of artificial leather.

The uses of ammonia in industry are many and varied. The greater part of our production in times of peace is used in the manufacture of fertilizers, and in the refrigeration and chemical industries.

The high boiling fractions of coal tar distillation, not suited to the manufacture of explosives, find extensive use as wood preservatives, road surfacing materials, and in the manufacture of roofing materials. The pitch left behind after the distillation of the tar is a very pure grade of carbon, and as such is extensively used in the manufacture of electrodes.

These many and varied uses of the materials recovered in the by-product ovens seem to insure the continued increase of this type of oven in the future.

2. *Cotton.*—In 1918 almost twenty per cent of our total crop of cotton was nitrated in our explosives plants, but less than one twenty-fifth of this went into the manufacture of guncotton, the remainder being used in the manufacture of smokeless powder. In view of the decreasing importance of guncotton as a military high explosive there seems to be no reason to fear that our supply of cotton for the manufacture of this material will ever be inadequate.

3. *Mercury.*—In spite of the rapidly increasing production of fulminate, the total amount of mercury consumed in its manufacture is but a small part of our national production. In 1918 more than 36,000 tons of mercury was produced in the United States and only 390 tons were used in fulminate manufacture.

4. *Ethyl Alcohol.*—Ethyl or grain alcohol is obtained principally by the distillation and rectification of the product of fermentation of fruit juices, molasses, and the sugar produced by the action of the diastase in malt upon the starch in grains and vegetables.

Our distilleries can easily be adapted to the production of high proof alcohol, and fortunately the eighteenth amendment to the Constitution does not prohibit the manufacture of alcohol for other than beverage purposes. The manufacture of grain alcohol is, however, so heavily taxed, and the requirements of our laws so exacting, that the price to the consumer is greatly increased.

As the consumption of alcohol in industry is increasing in spite of the restrictions upon its sale and use, production is increasing to keep pace with the demand. Since there is every reason to expect a continuing increase in consumption and production, particularly in view of the fact that alcohol may some day compete with gasoline as a motor fuel, we may confidently count upon a supply of alcohol sufficient to satisfy our needs in the manufacture of high explosives. The quantity required for this purpose is insignificant in comparison with the amount used in the manufacture of our smokeless powder.

5. *Methyl Alcohol.*—Methyl or wood alcohol is obtained by the dry distillation of wood. Our forest resources are still so great that there is no apparent danger of a lack of the small

amount of wood alcohol used in the manufacture of high explosives. However, when one considers the many uses of our forest products, such as the varied uses of paper and of articles made from paper pulp; the wide variety of materials known under the general classification of "naval stores"; and the multitudinous uses of lumber in our industries, he is at once impressed with the fact that the rapid destruction of our forests is a national calamity, and that prompt steps toward reforestation are essential to our future prosperity.

6. *Starch.*—This nation is one of the largest producers of starch-containing cereals and vegetables and should consequently have no fear of lacking the relatively small amount of starch required in the manufacture of nitro-starch explosives. It is true that only certain varieties of starch have been successfully nitrated, and that special methods of purification are necessary, but the experience of the late war demonstrated that plants for the production of the starch desired could be erected and put into operation with sufficient rapidity to insure an ample supply for the nitro-starch factories.

7. *Chlorine.*—Chlorine gas was used by us in large quantities during the World War in the manufacture of picric acid from benzene. Most of our chlorine comes from plants engaged in the manufacture of soda by the electrolytic process. The chlorine gas which was formerly a most objectionable waste product is now used in the manufacture of bleaching powder. Fortunately the volume of business done by this industry is so great that ample supplies of chlorine are available for the manufacture of explosives in time of war.

8. *Soda.*—The specifications under which practically all of our explosives are manufactured require them when delivered to be free from all trace of the acids used in their manufacture. Usually a small amount of sodium carbonate or bicarbonate is dissolved in one of the washing waters to neutralize any acid that might still be present. The amount of soda required for this purpose, even when our production of explosives was at the maximum during the war was negligible when compared with our monthly production, which averaged more than 300,000,000 pounds.

SUMMARY

In the production of high explosives, as in almost every other branch of war activities, America "made good" in a manner exceeding even the fondest hopes of her friends. At the time of the signing of the armistice our production of military high ex-

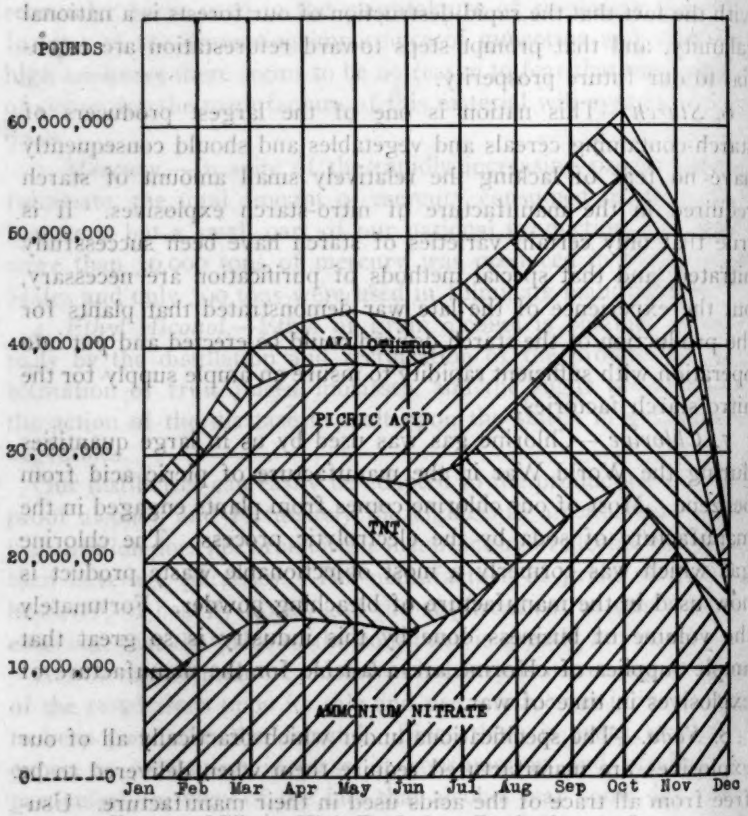


FIG. 14.—Military High Explosives Production, 1918.

plosives was at a rate forty per cent greater than that of Great Britain and almost double that of France. Our total production in 1918 is shown in Fig. 14.

The results achieved after we became a belligerent cannot, however, be taken as representing what we could have accomplished in a similar time with the explosives industry of the

country in a normal condition, for our production of explosives had greatly expanded before we entered the war.

The huge plants which rendered possible our war production of explosives have now largely been dismantled or converted to other uses, so that we would not be able to resume production at the rate possible at the time of the armistice without a considerable interval for preparation. Nevertheless, the development of our resources of raw materials, the perfection of manufacturing processes, and the experience gained in actual quantity production are real national assets which will be invaluable in case of future need.

At the cessation of hostilities our production of high explosives was still increasing rapidly, and there is no cause to doubt that if allowed sufficient time we can produce much larger quantities of military explosives than any other nation in the world.

Our entire production of explosives is, however, dependent upon imports of nitrate from Chili, and hence may be greatly reduced or even brought to a halt by the operations of an active naval force, even though the latter be inferior in strength to our main fleet. This deplorable dependence upon imports for materials required in the manufacture of our explosives can be eliminated by the establishment of plants for the fixation of atmospheric nitrogen, and no efforts should be spared to insure the prompt establishment of this industry in this country.

Every encouragement should also be given our struggling dye industry, both because of the ready adaptation of dye processes and plants to the rapid production of explosives in the event of war, and because the dye industry in time of peace encourages increased production of the materials required in the manafacture of explosives in time of war.

If dye manufacture be encouraged, the use of by-product ovens in the manufacture of coke be increased, and the nitrogen fixation industry be established on a scale corresponding to our natural wealth of the other materials required in explosives manufacture, America need have no fear that, in case of aggression by a foreign power, her army and navy will ever be handicapped by any lack of high explosives.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

RADIO EQUIPMENT ON *NC* SEAPLANES

By LIEUT. COMMANDER ROBERT A. LAVENDER, U. S. Navy

The prominent part taken by radio apparatus in the trans-Atlantic flight of the *NC* seaplanes has emphasized the uses and needs of such radio apparatus during long flights along the coast and the absolute necessity of efficient apparatus within reasonable limits of weight for the commercial trans-Atlantic air lines which will be organized in the future. It is a curious fact, but yet to be expected, that when the designers and the pilots of air-craft think of radio sets, they invariably think in pounds. Pounds of weight and pounds of head resistance mean pounds of gasoline and oil. And pounds of gasoline and oil mean speed and endurance. But what good would extra pounds of gasoline and oil do if communication and navigation were made uncertain and the lives of the crew and passengers jeopardized when lost during a fog or when drifting on the water with no means of communication? The 26 pounds of radio equipment (emergency transmitter) removed from the *NC-3* at Trepassey Bay, because the plane could not get off the water with full load, should have remained on board for it would have been worth its weight in gold when the *NC-3* came down on the water, a few hours later, 50 miles south of the Azores, with 160 gallons of gasoline, but with no means of communication.

When the radio apparatus was selected for the *NC* seaplanes, the greatest consideration was to carry a minimum of weight and still to have a small factor of safety. A limit of 260 pounds—less than 1 per cent of full load—was allowed for the radio apparatus, although the designers of the seaplanes really expected this amount to be exceeded. The apparatus was to include two complete and separate antenna systems; the radio compass; a

receiver and amplifier; two complete and independent transmitters; and sufficient electrical energy in storage and dry batteries to give continuous operation over the longest leg of the route, and to have four hours of continuous operation on the water with the emergency set.

All this apparatus, except the spark transmitter and the coil of the radio compass, was assembled on a small table (see Fig. 1) located in one corner of the after gasoline and engineer's compartment. The general location is indicated by the *X* in Fig. 2.

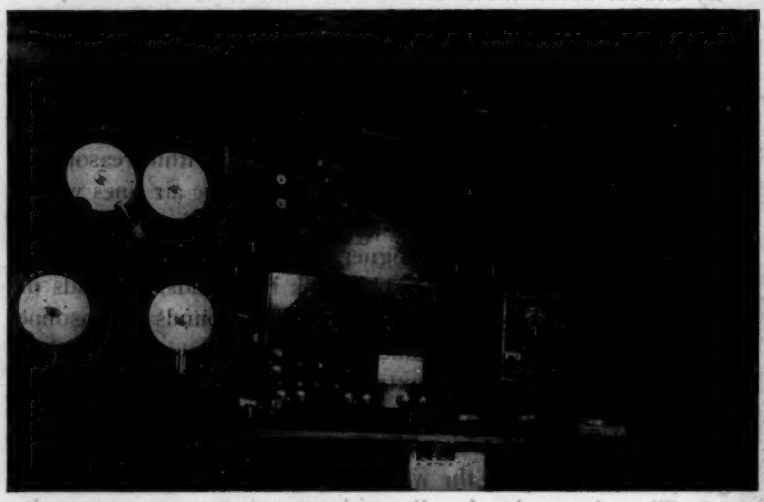


FIG. 1.—Radio Equipment, *NC-3*.

Much to the relief of the designers and the pilots, no accident occurred during any of the tests or final flights due to the sparking of the radio apparatus in the strong gasoline fumes which were always present in the compartment, and almost equally important in the eyes of the designers and the pilots was the fact that the total weight of the radio apparatus was only 250 pounds, 12 per cent less than was allowed and 27 per cent less than had really been expected.

The two antenna systems on the planes consisted of a "trailing" antenna and a "fixed" or "skid-fin" antenna. The trailing wire was 250 feet in length and led out through the hull directly above the radio table, and thence aft to an insulator on

a brace wire, from which point it was suspended. The wire was held in a vertical position by a small, stream-lined, lead weight suspended at the end. When the planes were getting on or off the water, the wire was reeled in on a drum shown at the extreme right of Fig. 1. Connections were made to this wire as it passed through the metal core of the deck insulator. The fixed antenna consisted of a rectangular coil of wire suspended from the skid fins above the upper wing. As the brace wires in and between the wings of wire grounded, the effective range of the fixed antenna was only less than one-quarter of the range of the trailing wire. It was designed for use only when on the water but

FIG. 2.—"Official Photograph, U. S. Naval Air Service."

it served a more important purpose when the trailing wire was ripped off while flying low. Without the fixed antenna we would have been without communication during part of two legs of the flight.

Particularly important in seaplane radio installations is the radio compass. Much has been said and written about the use of the radio compass on board ships and at shore stations where ideal conditions can be realized. There, the location can be selected for its distances away from masses of steel and wires not enclosed in metal conduit. It is to be expected that the radio compass ashore and on ships will work and work well. But on board seaplanes the radio compass has been handicapped, espe-

cially so on board the *NC* type, in which the radio compass was not easily placed or its location freely determined. By force of circumstances and by the necessity of limited space, the radio compass was installed in the only position for it, in the after compartment of the hull, amidships. There it was surrounded not only by the interior electric lighting wires and the brace wires in the hull, but also by the control wires passing back to the tail. These wires shielded and distorted the radio waves as they passed around the compass coils, and caused errors which had to be determined and allowed for. But still more disastrous to the operation of the radio compass was the fact that these wires, being connected to the common ground of the ignition system, formed an antenna to radiate and bring closer the effect of the ignition disturbances, which disturbances are of the same general nature as radio waves and have the same effect as radio waves on the compass coils and apparatus. Nevertheless, with all these difficulties, electrical remedies were applied such that the effect of the ignition system, though not eliminated, was somewhat reduced. Operating the compass revolving control cables with one hand, and the electrical controls with the other hand, listening with both ears to the signals, and watching the pointer over the coils, it required the greatest of concentration on the part of the operator to listen to the signals through the outside disturbances and it required the greatest of care to judge the intensity and thus the direction of the signals.

During the preliminary tests of the radio compass on the *NC-2*, an accurate range of 50 miles was attained but before the flight was taken with the *NC-1*, the *NC-3* and the *NC-4*, the connections of the ignition system were changed to increase the ignition efficiency but which reduced the radio compass range to 15 miles. Unfortunately no opportunity was given, while the resources of a research laboratory were near by, to overcome these disturbances and the flight was attempted with this range. At the Azores the connections of the ignition system on the *NC-4* were again changed but to no advantage to the radio compass. Shortly after leaving the Azores the auxiliary or duplicate spark plug part of the system was put out of commission by burnt out contacts, and as in this part of the ignition system had been located the cause of the greater portion of the ignition disturbances, the radio compass functioned with its former range of 50 miles. It was

providential that this part of the ignition system did fail at this time as the *NC-4* had drifted nearly forty miles off her course due to rough air and an accident to her magnetic compasses, and was practically lost. It was the radio compass which brought the *NC-4* back to the line of destroyers and thence into Lisbon.

Closely allied with the radio compass was the radio receiver. The radio compass itself may be considered a directive receiver, but owing to the small area that it embraces, and because all of its wire was so close to the ignition disturbances, it could not be used for long range reception. Fortunately, the shortcomings of the radio compass as a receiver were not found in the trailing wire, which made an ideal receiver. A notable case in point was a message intercepted while the *NC-4* was in flight approaching the Azores. It came from the U. S. S. *George Washington* 1800 miles away. She was getting into Brest, France, and her radio message which was intercepted was one reserving space on the next morning's train for Paris. This is the record for long range reception by any plane in flight.

The sensitiveness of the radio compass and the receiver and the long ranges obtained with them depended almost entirely upon the amplifier, which was of a six stage vacuum tube type. The amplifier, as will be seen in Fig. 1, was mounted on elastic supports to prevent the vibrations of the hull from affecting it. The amplifier complete was only 12″ x 9″ x 4″ and weighed but 12 pounds. Yet this 12 pounds of apparatus amplified the incoming signals to 50 times the strength they would have been had the best previously known receiver and amplifier been used in its place.

Another interesting feature in the equipment of the *NC* planes was the interior telephone system. This system made it possible for any two persons in the plane to carry on a conversation at any time. A specially improved helmet was developed to hold, directly over the ears, two deep soft rubber ear cups in which were located the head telephone-receivers. The sides of these ear cups were high enough to allow each cup to be fitted to each individual person by cutting it away in places. The helmet itself was received from the factory open at the back and then was fitted to the head of each individual. The microphone, or the part into which one talked, was so constructed that the back of the diaphragm as well as its outward face was exposed to the engine

noises. The effect of the engine noises on the diaphragm was therefore balanced and it failed to respond to any sound waves coming from a distance and only when the lips were placed directly in front of the diaphragm and the sound waves of the voice were thus concentrated on one side, did the diaphragm respond and was speech transmitted. With the sound proof helmets and the special anti-noise microphones, it was not only possible but easy to carry on a conversation, in spite of the 48 cylinders which were roaring continuously only a few feet away. Before the *NC-3* descended near the Azores, the question of landing was fully discussed over the telephone by the two pilots and the navigator. The opportunity of a conference in the air can not be appreciated until after one has been placed in such a position as was the crew of the seaplane, lost in a fog with only a limited supply of gasoline.

The transmitter on which the greater reliance was placed was a ½ kilowatt wind driven spark set mounted on a strut under one of the engines, where it was exposed to the passing air. All the circuits, except the field switch and the variometer, were mounted behind the generator, in the hollow shell required to make the generator "stream-lined" or adapted to air resistance. The spark gap and closed and open oscillating circuits were so arranged that the various leads passed back from one circuit to another until the high tension current, ready for the antenna, was picked off from a clip connection in the tip end of the tail. The complete set weighed but 44 pounds and yet was heard 1200 miles. The two-blade propeller was designed to deliver full power when the seaplane was flying at its slowest flying speed, 65 miles per hour, and as this air speed is approximately the speed of the air behind one of the propellers of an engine when run while the plane was on the water, the same radio set could be used as an emergency set, provided that the engines could be run. But when the *NC-3* landed on the water and the set was thus mounted, the forward motion given to the plane by the pull of the engine caused heavy strains on the already weakened hull, which jumped over and dived into the waves instead of drifting over them. For this reason, grimly as the need was felt, it was considered too dangerous to try to use the set.

The other transmitter, known as the emergency set, is shown mounted on the radio desk. The high voltage required for this

set was obtained from a dynamotor driven by a storage battery, which battery also furnished directly the low voltage current. This little transmitter was capable of radiating .8 of an ampere, which under normal conditions would give a range of 75 miles. The transmitter proper weighed but 8 pounds and with the dynamotor weighed only 26 pounds. It paid for its weight when the *NC-3* landed 40 miles from Halifax. Communication was established with the tender, the U. S. S. *Baltimore,* within 50 seconds. The tender was informed of the location of the plane, the trouble encountered, and the fact that no assistance would be required. This set, because of its 26 pounds of weight, was removed at Trepassey Bay.

Some unit of the radio apparatus above described was in use practically every moment from the time the planes left Rockaway Beach until they reached their several destinations. The radio operator was constantly either sending a message, or listening to the radio compass signals or copying a message from the destroyers. Just as the planes were off Chatham, on Cape Cod, the noon time signal from Washington was received in the planes and the chronometers given another check. Secretary Roosevelt in Washington desired to send a message to one of the planes and to receive a reply. So quickly was the communication carried out that (1) the message was forwarded to a shore radio station, (2) the plane was called and the message delivered to the plane, (3) it was referred to the commanding officer by telephone, (4) the reply was given to the operator, (5) the shore radio station was called and the reply sent to the station, (6) the reply was forwarded to Washington and (7) before ***three minutes*** had elapsed, Secretary Roosevelt received the reply.

In contrast to this efficient service of the radio equipment was the urgent need of communication by the *NC-3* floundering about in the heavy seas off the Azores, unable to send any message at all because the apparatus designed for such a crisis was left behind on account of its weight. Only the receiving equipment could be used, which told of the plans of search and the "Estimate of the Situation." Later, as we were drifting into port, the apparatus did its final bit: we intercepted—"*NC-3* sighted on water seven miles from breakwater Ponta Delgada under her own power."

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

POLICY—ITS RELATION TO WAR AND ITS BEARING UPON PREPARATION FOR WAR

By COMMANDER C. C. GILL, U. S. Navy

Policy, broadly speaking, maps the destiny of a state in the fulfillment of national aspirations as seen and interpreted by those in governmental control.

When national policies conflict, as they continually do and must, diplomacy, backed by potential power, attempts to negotiate a settlement by the medium of official notes and interchanges. These do not always succeed. Then, if the difference is justiciable, susceptible of decision by the application of principles of law and equity, joint appeal may be made to some international court such as that of the Hague; or, if the dispute is purely political and non-justiciable in nature, the nations involved may, by special agreement, resort to a tribunal of arbitration in the hope of arriving at a satisfactory compromise or other suitable arrangement.

But sometimes all attempts at peaceful adjustment fail. Then, if the issue affects the vital interests, the independence, or the honor of the disputants, it has been the experience of history that war usually results and each belligerent strives by force of arms to sustain its avowed policy. Active war is a continuation of policy by violent means.

"UNLIMITED WAR" AND "LIMITED WAR"

It follows that wars are of various kinds according to the policies they are called upon to support. If the object is of great national importance, a matter of self-preservation in which the peoples of the belligerent countries are deeply aroused, and if the two contestants are evenly matched nations or combinations of nations of the first rank, then each side will institute extreme

military measures, the utmost resources of the countries engaged will be under contribution—in such a struggle entire nations are in arms and the course of the civilization of the world may be in the balance. In so far as the chief participants were concerned, the World War of 1914-1918 is an example of this class known as "Unlimited War."

On the other hand, if the matter under dispute is of minor importance, a question relating to a distant possession, an issue toward which the people at large are indifferent, or a contention wherein the parties concerned are of unequal strength, then the objective may not be worth any great military effort, or the weaker belligerent may be incapable of offering significant opposition; in any such case, the point in policy under controversy will be conceded by one side or the other without extensive military operations. Wars of this class may prove of great importance in their ultimate influence on the history of the world, but they are decided without a wide disruption of society or far reaching derangement of the usual pursuits of peace. The Boer War in the Transvaal and the Spanish American War may be cited as familiar examples belonging to this second class called "Limited War."

Policy, therefore, controls the declaration of war, determines its nature and extent and is its master. The statesmen must instruct the strategists as to the political object of the war, and the extent of effort the nation is willing to make to attain it, before the latter can draw plans for its prosecution. In illustration, it is at once seen how the war plans drawn by the strategists of Brazil to govern her participation in the World War were, for political reasons, limited in demanding expenditure of national effort, as compared to the war plans which governed the participation of France.

Policy dictates grand strategy, which, in turn, determines the mutual relations and respective functions of its two branches, maritime strategy and land strategy. The line distinguishing policy from grand strategy is not sharply drawn; to wage war successfully politicians and strategists must meet on common ground and evolve a general plan of campaign to guide and coordinate major operations both ashore and afloat.

THE FUTURE OF WAR

No discussion of policy would be complete without reference to the deep and earnest desire of mankind to safeguard the future against the catastrophe of war. The aspiration for honorable peace is shared by all high minded peoples irrespective of color, race, language, or geographical location, and is much in evidence in modern policy.

With the sufferings entailed by the world conflict fresh in memory, it was to be expected that revulsion to war should find strong expression in the enlightened statesmen gathered around the Peace Table at Versailles. Such was the case and there is nothing new in this. The same sentiment has been evidenced after all the great wars of modern times.

The ideal of world peace dates far back in history and has been recorded in numerous state papers, treaties, and conventions. Now we have the League of Nations, as the most recent manifestation of this world-wide wish to substitute law and order for the violence of war. If there is any immediate prospect of the practical realization of this wish it will have a direct bearing upon policy and especially upon the question of preparation for war.

As a result of Allied victory democratic forms of government are now in the ascendency. This favors the purposes of the League of Nations and if consolidated may well constitute a step toward the establishment of conditions which may eventually bring the ideal of world peace into the field of practical politics.

It is also a gratifying consequence of this war that the sympathies aroused, the community of principles voiced by many peoples, is unmistakable indication of advance toward an approximate unification of mankind. But, in order to reap the full benefit of these advances it is important to understand their limitations and to appreciate that, after all, they are only steps along a road which is sure to be long and difficult.

Danger lies in the beauty of the ideal. This, by influencing reason to capitulate to the bias of sentiment and inclination, may prove a serious menace to the very cause it seeks to promote. "The flower is not hastened in its growth by holding it to the flame." Harm rather than good results from attempts to contravene the slow processes of evolution ordained by nature. The goal of a lasting world peace is one which cannot be reached by

short cuts, and attempts to do so will only result in increased difficulty and delay.

War is a great evil but there are others greater. History has taught that when two policies conflict, moral motives on the one hand avail little against unscrupulous ambition on the other, unless the reasonable contention of the former be backed by adequate physical force. A war which causes good policies to triumph over bad is not an unmixed evil. So used it is preventative and remedial against dangers and diseases which menace the progress of civilization.

Many instances in history may be cited, wherein policy had to decide between just war and dishonorable peace. Of these, three of the 19th century might be mentioned—Crete, Armenia and Cuba. In the cases of Crete and Armenia, war was avoided, but at what a price: the cause of humanity was sacrificed and national consciences surrendered to iniquity. On the other hand, in the case of Cuba, war was preferred, and few people will contend that this just war entailed greater evil than would have been incurred had the United States submitted to the continuance of a dishonorable peace.

But here the objection may be made that these evils greater than war have at last been eliminated, that the overthrow of Hohenzollern ambition marked the final need of war for any such purpose. To this it may be answered that the same thing has been said many times in the past and has always proved an over sanguine and premature assumption. It would hardly be prudent to accept this objection without more convincing demonstration of its truth than is now available, although, as has already been stated, there is encouraging indication that the spread of democratic forms of government may tend to reduce the evils which cause wars of this class. Even after this has been accomplished, however, there still remains another class of wars, the causes of which must also be eliminated before disarmament can safely be proceeded with in the security of world peace.

This type of wars includes those resulting from a clash of policies in which the moral motives of neither one of the belligerents can be fairly impugned. It may happen, and not infrequently has happened, that both sides wish to be guided by moral motives and yet fail in the peaceful settlement of their dispute, because of an honest irreconcilable difference of ethical

opinion. A difference of opinion in which neutral judges might also be equally divided.

This condition will continue until all peoples of the world are influenced by the same moral motives in the same way, and are bound together in a common desire for peace by a natural community of interests. Then all mankind can intermingle and meet for discussion on the same plane or approximately the same plane. It is obvious how far the nations of the world as they now exist, are from this ideal state of reciprocity and agreement.

In illustration of present day divergence, it is well to consider the situation in the Pacific. We have here on one side of this great ocean Asiatics, and on the other side English speaking communities of a quite different race. The former are by far the more numerous in population while the latter in America and Australasia possess an equally disproportionate greater extent of sparsely settled territory.

Racial characteristics and the evolution of history have placed these peoples on different planes of spiritual and social development. The English-speaking communities have evidenced a deep-rooted determination to prevent Japanese and Chinese immigration. The Asiatics object to this and other discriminations against them. Here we have the alleged right of prior possession of property arrayed against the alleged right of equal opportunity for expansion. This is not a new situation in history, and in the past, sometimes the right of possession has prevailed and sometimes the right of expansive growth. The ethical arguments which enter appear to be of such equal balance on the two sides as to render a decision extremely difficult by any principles of law or equity which have so far been established. What persuasion is going to convince intelligent Japanese that it is morally wrong for them to use force to attain what principle and custom indicates to them to be a right? And again, looking at the question from the other angle, what argument can be advanced which is likely to move the inhabitants of California to the admission that their contention of property rights by which they exclude Asiatics is unjust?

Until the barriers which separate nations are broken down, until the relations between Asiatics and Californians are on a parity with the relations between Californians and New En-

glanders—it is clear, when such situations arise as the above, that the policy which will prevail, either in peace or in war, will be the one which is backed by adequate physical force.

Experience and logic indicate that an approximate world unification is a pre-requisite to lasting peace, and that this can only be effected, if it can be effected at all, by a series of wars, the extent and violence of which will depend largely upon the qualities of measuredness and wisdom displayed by those in governmental control in formulating and carrying out the policies of the various states which make up the society of nations. Hence, it is of primary importance that statesmen should study war and its causes, try to lessen its frequency and virulence without impairing its usefulness, and at the same time endeavor to eliminate those evils and resistances which can be overcome only by physical force.

THE BEARING OF POLICY UPON PREPARATION FOR WAR

In due process of time an adequate code of international law and machinery for enforcing it will doubtless be evolved, but, in the meantime, war will have to continue as an instrument of policy. As long as this condition lasts prudence requires that policies be insured by adequate armed force which includes special safeguards such as frontiers protected by mountains, water or other barrier to unlawful aggression, and properly defended lines of communication to outlying possessions.

In a crisis, and in preparation for a crisis, fortunate indeed is the nation whose trustees for the future, those who shoulder the responsibility of governmental control, understand and conform to sound principles in shaping and carrying out an insurance policy of national defense. This is an urgent question affecting the public welfare and the fact that it is intricate and difficult makes attention to it the more important.

Numerous considerations enter and interact on each other in a confusing way. Some of these are of an elusive and unstable nature. Consequently wide diversity of opinion frequently results. The interests involved, moreover, are largely of the future and therefore not brought home to the average citizen whose chief concern is the business of the present. In deciding matters of national defense it is not surprising that prejudice and expediency so often overrule logic, especially under the

shifting statesmanship of democracies. The subject itself, however, is capable of scientific analysis. A satisfactory solution—a matter of growing importance as improved means of communication draw the peoples of the world closer together—is not to be arrived at by evasion or guess work. And it may be added that there is promising evidence that in the future a better informed public opinion will not be so tolerant as in the past of blunders caused by ignorance and stubborn sentimentalism, but will demand that national affairs be managed in an honorable business-like manner. The field is one of cooperation between statesmen and their military advisers.

The particular function of the statesman is to set forth the policies of the nation, indicate how they do or may conflict with the policies of other nations, and distinguish between policies which are vital, and those which are merely desirable. This information having been supplied, the particular function of the military adviser is to point what armed force is required to make these policies prevail either through potential influence in peace or by active use in war. Taking into consideration the resources as well as the aspirations of the nation, the responsible statesmen must then decide what policies shall be insured by the provision of armed force and what policies should be pushed only so far as is possible in peace, with the idea of abandoning them rather than to incur the hazard and expense of war. This is a question of what a nation can do and is willing to do to safeguard its interests.

It is thus seen that the line of demarcation between the province of the statesman and that of his military adviser is fairly well defined. This does not mean that the former should not concern himself with army and navy matters nor does it follow that the latter should remain ignorant of statesmanship. On the contrary, the more each knows of the entire subject the better, and it is essential to cooperation that each should know at least the broad principles which guide the other. At the same time, the line of divided responsibility should be clearly understood and remembered in order that ill-advised trespassing may be avoided. In this connection it may not be superfluous to observe that regardless of whether the government sees fit to provide an army and navy in accord with expert advice or not, it is the duty of those in the military services to make the means that are provided, be

they great or small, as efficient as possible and in active employment as effective as possible.

PRINCIPLES OF POLICY

In making and promoting state policies two considerations enter, one of self-interest and one of ethics. In this respect we find that the fundamental rules of policy governing the relations between nations are not very different from the rules of conduct governing business and social relations between men.

In a community of individuals each man seeks to increase his wealth and to add comfort and pleasure to his own life and to that of his family. Nor do his neighbors question the propriety of this objective so long as the means employed are honorable and do not infringe the rights and privileges of others. It is recognized that the worldly success of a good citizen benefits his community.

It is similar to this in the community of nations. Policies of self-interest, to increase the wealth, power and influence of a state, are the outcome of a natural ambition for progress, and so long as they are furthered by just and honorable means such policies advance the cause of civilization and contribute to the world's welfare. National wealth and power, under control of a good government, commands respect and exerts a beneficent influence in the conduct of world affairs, just as wealth honestly amassed and wisely used by an individual commands respect and works for good in the business affairs of men. It is thus seen that there is a balance between self-interest and altruism. Power of doing good is not helped but hindered by blind idealism which neglects the essentials of self-interest. This applies equally to individual men and to nations. But in this, as in nearly all arguments by analogy, pitfalls will be met if the comparison is pressed too closely. There are marked points of difference between a community of individuals and a community of nations. For one thing, the regulation of intercourse between men has reached a more advanced stage than has the regulation of intercourse between the various states of the world.

In summing up it may be fairly stated that self-interest constitutes the major consideration of state policy, and that it should be frankly accepted as the adequate motive which it most assuredly is. It is a fundamental of human nature, and under the

control of enlightened intellect is worthy and productive of happy consequences. This is not to say that sentiment and idealism have no place in policy. On the contrary they have an important influence on and are closely associated with the more materialistic considerations. In the grouping and regrouping of nations, in the movements of humanity which make up the history of the world it has been shown that the ties of blood and language have a holding power not to be overlooked, that these, however, do not bind as do territorial limits and the forces of physical propinquity, and finally that neither racial ties nor boundary lines, nor do the two together arouse human passions and influence combinations and separations of men as do pressures exerted by economic conditions.

State policy may be said to rest on three principles:

1. *The Principle of Self-Interest.*—Economic considerations count first, territorial second, and racial or ethnological considerations third.

2. *The Principle of Humanity.*—No nation will long endure whose policies violate the moral code of civilization.

3. *The Principle of National Defense.*—A state too weak to defend its policies must be prepared to give way to more ambitious rivals.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.
[COPYRIGHTED]

HOW THE *CUSHING* TOWED IN THE *MURRAY*

By Lieutenant (J. G.) Paul W. Hains (C. C.), U. S. Navy

Those officers who were stationed at Brest, France, about Thanksgiving, 1918, will recall the episode of the grounding of the *Connor* and the *Murray*, two destroyers who were returning from a "Limey" outing of four days in company with four other destroyers. The *Connor*, senior and therefore at the head of the column, made a rather unusual mistake. It was early in the morning, and the weather was growing thick. She identified Isle Vierge Light for Ouessante; and in turning to port, presumedly to round the latter island, piled well onto the hidden rocks which so infest that part of the rocky French coast. Before the news of the grounding could be flashed to the other craft, the *Murray* had also gone aground and had ripped a huge opening in her bottom about amidships. While the *Connor* (having damaged her shafts and propellers) prepared for the worst, with the wrecking tug *Favorite* standing at full speed up the dangerous Le Four Channel to her rescue, the *Murray* was swung clear of the treacherous rocks by some kind Providence, and started for Brest under her own steam. Very soon, however, this more fortunate of the two vessels realized that she could not maintain even the meagre five knots with which she had started for Brest, and she accordingly signaled for help. The *Cushing*, being the only destroyer within visual distance at that time, made preparations for taking her in tow.

The whole story furnishes most excellent material for wardroom or quarterdeck chats. But it is the purpose of this article to explain how the various problems in seamanship that arose were solved—to tell how the *Cushing* took the *Murray* in tow, how the *Cushing* steered a fair course under adverse circumstances, and

how she eventually transferred the tow-line to a tugboat just outside of Brest Harbor.

The first problem was, of course, to pass a tow-line to the *Murray*—not considered a difficult task generally. On the occasion in question, however, a strong wind and high seas, together with intermittent rain, which rendered lines cranky and unmanageable, combined to make the situation and problem in hand anything but simple. In fact, four different attempts to pass the tow-line, each involving a distinct principle, were made by the *Cushing* before success was attained.

In the first attempt to pass the line the scheme seemed simple enough, it being merely to steam up abreast the *Murray* and drop a line overboard, with a spar or keg attached to the free end. The *Murray* was to pick this up. Accordingly, a good size spar was bent to one end of a five-inch line, and the usual towing gear was laid out on the fantail. The *Cushing* steamed at one-third speed past the *Murray;* the line and spar were heaved overboard, but not until the *Cushing* had almost passed the Murray. The result was inevitable. The line could not be paid out fast enough and the spar was dragged out of the range of the *Murray's* grappling irons.

The second attempt was of similar character but based upon the known fact that a ship will drift in a strong wind faster than a small object in the water, due to the greater wind surface offered by the ship. The maneuvers of the first attempt were repeated with one exception. The *Cushing* steamed slowly past the disabled destroyer in the same direction as that in which she was headed, but to leeward of her this time. The spar was dropped earlier, but still not early enough. When clear of the *Murray,* moreover, the *Cushing* failed to check her speed by backing on both engines; and the net result was as fruitless as before—the spar was dragged far past the *Murray* before that ship could get the line with her grappling irons. Had the *Cushing* dropped the spar some 50 yards astern of the *Murray* and then, when once clear of her, completely stopped her own ahead motion, there is no doubt but that this method would have proved successful. The principle is undeniably excellent. But in its application these two points must be strictly observed or else failure will result: (1) The spar must be dropped far enough astern so that

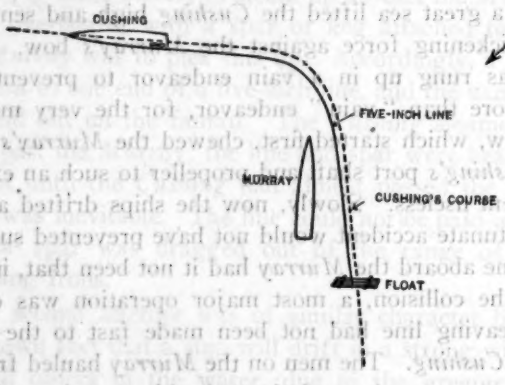
it will not be dragged across a line extending directly to leeward from the disabled ship; and (2) ahead motion on the rescuing vessel must be completely stopped when she is clear of the other craft.

If that line were ever to join the two ships, it became apparent, a little patience, a good deal of judgment, and no little common sense would have to be employed. Why not back down upon the *Murray,* send a heaving line across her bow, and make the five-inch line fast to the end of the heaving line for a third try? It seemed reasonably safe, even with some 1800 pounds of TNT on the *Cushing's* fantail. It was tried. The heaving line shot true, and a sigh of relief went up from all hands—but too soon. Almost at once a great sea lifted the *Cushing* high and sent her hurtling with sickening force against the *Murray's* bow. Full speed ahead was rung up in a vain endeavor to prevent the impact—nay, more than "vain" endeavor, for the very motion of the port screw, which started first, chewed the *Murray's* bow and bent the *Cushing's* port shaft and propeller to such an extent as to render them useless. Slowly, now the ships drifted apart. Even this unfortunate accident would not have prevented success in getting the line aboard the *Murray* had it not been that, in the excitement of the collision, a most major operation was overlooked. The heaving line had not been made fast to the five-inch line on the *Cushing.* The men on the *Murray* hauled frantically on the messenger only to find on the bitter end—nothing. In a few seconds time the *Cushing* had succeeded in losing her port propeller and incidentally a heaving line; and she was no nearer her objective, except perhaps in experience.

The fourth, and successful, attempt was planned carefully and executed with precision. First a heavy float was made to replace the spar which had previously been used. This was accomplished by lashing together several heavy oars and bending them to the free end of a very long five-inch line. The *Cushing* then took up a position well abaft the *Murray,* and when all was in readiness, steamed very slowly past the *Murray* to windward of her. The line and attached float were hove overboard at a point well astern of that ship. Five men were employed to pay out the line as fast as possible. And, now, instead of holding her course, the *Cushing* crossed the bow of the *Murray* close aboard, and when clear of the *Murray* stopped all headway. This resulted in having the

five-inch line lie in a bight about the *Murray's* bow, as illustrated in the accompanying sketch.

By alternately heaving in on the line and then allowing it to sag again the whole line was worked bodily towards the *Murray* slowly but surely. In this operation the large float acted as a sort of sea anchor. Every time men on the *Cushing* hauled in on the line it tended to assume as straight a line as possible between the anchor and the *Cushing*, and in so doing it worked itself closer and closer to the *Murray*. Grappling irons soon made contact with the bight, the line was hauled aboard the *Murray*, and the stout eight-inch towing line was hauled aboard her. It only remained to make everything well secure before the *Cushing*



started ahead very carefully and very slowly with the disabled ship in full tow.

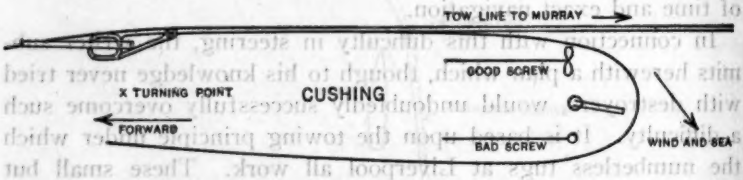
Before proceeding with the problems of steering that arose, it will be well to point out certain conditions, in order to make clear the difficulties encountered. The vessels had to hold a southwesterly course (later a southerly one). Wind and sea were on the starboard bow, and only the *Cushing's* starboard screw could be used. These facts, coupled with the further one that the tow line was led in through the stern chock of the *Cushing* and around the after gun base, made it absolutely impossible to make anything to starboard. Indeed, with helm hard aport it was not possible even to hold the course, much less to make anything to starboard, *i. e.*, to windward. Wind and sea, and the drag of the idle port propeller, combined to make the bow persistently edge off to port. But even stronger was the com-

bination produced by the ahead push of the starboard screw and the tension, due to the towline, on the after gun base. Each of these pulls amounted to several tons, and the arm between them to two or three feet. In this way they made, it will be seen, a powerful couple tending to turn the ship to port. Accordingly, whenever it became imperative to make a more westerly course it was necessary to wear ship completely, and to tow the *Murray* in a long tedious circle back over old tracks to the desired new course, which might be only an exasperating five or six degrees to the westward of the old one. This problem was not satisfactorily solved. Perhaps a dozen times during the 26 hours in which the *Cushing* drove doggedly ahead with the almost waterlogged (if the term may be used with a steel ship) *Murray* in tow, it was necessary to wear ship in this fashion, at the expense of time and exact navigation.

In connection with this difficulty in steering, the writer submits herewith a plan which, though to his knowledge never tried with destroyers, would undoubtedly successfully overcome such a difficulty. It is based upon the towing principle under which the numberless tugs at Liverpool all work. These small but powerful vessels operate in most confined bodies of water, sometimes inside the docks, and they are required to turn sharply and quickly. This is made possible for them to do by bringing the tow line from the large steamer to a point on the tug as near the turning point as possible. The deck fittings and superstructure are so built as to permit of this line's being made fast to a large swivel hook practically amidships. The writer's suggestion for a destroyer in a predicament similar to the *Cushing's* is simply to lead the tow-line forward to the starboard waist gun, taking care to keep the line well outboard and clear of all such things as torpedo tubes, davits, lifelines, and rafts. The advantage lies (1) in removing the anchor effect of the tow line from just above the rudder and placing it forward where it cannot pin the stern down; and (2) in introducing a new force at a point where it would tend to turn the ship in the direction it could not turn with the tow-line secured aft; *i. e.*, in this case to starboard.

Such an arrangement thus puts the good screw and the towing line, the two heaviest forces acting, almost in a straight line fore and aft. Each, accordingly, tends to counterbalance any turning moment introduced into the towing ship by the other; and at the

same time the *stern* of the towing ship is left free to swing a small amount to starboard and as much as is desired to port. With this arrangement a slight degree of right rudder would quickly turn the ship to starboard, while turning to port would be accomplished by slowing down the ship's speed just long enough to allow the wind, acting on the high bow and bridge, to swing the nose in that direction. It will be noted no doubt that the description applies strictly only to a vessel in the exact predicament of the *Cushing*, that is, with wind and sea on the starboard bow and the port screw useless. Other cases would naturally have to be modified to meet the conditions that held; but the same principle of applying the towing line at a point on the towing ship as near the turning point as possible would still be employed to decided advantage.



Projected Plan for Towing the "Murray."

Certain objections to the above scheme may be entertained. And chief among the objections is no doubt the fact that the waist guns on all new destroyers are on gun platforms at a considerable height above the water. Most certainly it would not be advisable to make the tow-line fast to a point so elevated. But the idea is to get the point of application of the towing force as near the ship's turning point as possible, and this should be worked out to suit the individual case. As suggestions, the chart house or the galley might be utilized on new construction, provided very strong stops are used on the line to hold it in a fixed position along the deck, especially where it goes over the ship's side. Needless to say, the tow-line, in any case, would have to be plentifully and judiciously protected from chafing at all sharp edges where friction, however small, might be expected. Few will probably claim as an objection to this departure that the bases of the waist guns on old destroyers are neither sufficiently strong themselves nor firmly enough embedded in the ship's framework to withstand the strain of the tow-line. Experience throughout the late war

with fueling at sea, and an examination of the deck fittings on the gun's bases and the reinforcing beams under the deck, preclude such objection.

The last problem the *Cushing* had to solve was concerned with the transfer of the tow line to the *Dreadnought,* a tugboat sent out to relieve the *Cushing* when the two destroyers were within the entrance to Brest Harbor the morning following the accident at Isle Vierge. It has been recommended as an efficient means of effecting this transfer at sea that the towing vessel bend a small, short line to the main towing line, outboard of the stern chock, and to a good sized cask of any sort that will float. The pelican hook on the towing gear is then slipped, and the cask and line are heaved over the side. The relieving vessel picks up the cask at her leisure. Such a method is all right if the tow line is not large and if the distance to the towed vessel is comparatively great. The disadvantage lies in the fact that a large tow line will not float, and, on the contrary, sinks fairly rapidly. The result is liable to be that the cask is dragged closer and closer to the towed vessel, due to the weight of the bight under water; and the relieving ship is forced to approach the towed ship dangerously close in order to pick up the cask. Again, if the water is shallow the bight of the tow line is in danger of fouling on some object on the bottom. Because of these considerations the above method was not essayed by the *Cushing,* but another one more seamanlike, safer, and involving no cessation of towing, was successfully tried. It was as follows. The *Cushing* held her course, towing the Murray, while the Dreadnough, the relieving tug, steamed abreast of her, close aboard and at the same speed. One end of a five-inch line was led in through the stern chock of the *Cushing* and secured to the eight-inch tow line. The other end was led forward, outboard of everything, to the forecastle, where an ordinary heaving line was bent to it. Men stationed at intervals along the deck held the five-inch line. This having been done, the heaving line was shot across to the tug. Thereupon the tow line was let go by tripping the pelican hook, and the men who held the five-inch line threw it clear. A few minutes sufficed for the *Dreadnought* to slow down and haul aboard successfully the messenger, the five-inch line and the large tow line. The *Cushing* proceeded to Brest:

with towing at sea, and an examination of the deck fittings on the gun's bases and the reinforcing beams under the deck, preclude such objection.

The last problem the *Cushing* had to solve was concerned with the transfer of the tow line to the *Dreadnought*, a tugboat sent out to relieve the *Cushing* when the two destroyers were within the entrance to Brest Harbor the morning following the accident at Isle Vierge. It has been recommended as an efficient means of effecting this transfer at sea that the towing vessel bend a small, short line to the main towing line, outboard of the stern chock, and to a good sized cask of any sort that will float. The pelican hook on the towing gear is then slipped, and the cask and line are heaved over the side. The relieving vessel picks up the cask at her leisure. Such a method is all right if the tow line is not large and if the distance to the towed vessel is comparatively great. The disadvantage lies in the fact that a large tow line will not float, and, on the contrary, sinks fairly rapidly. The result is liable to be that the cask is dragged closer and closer to the towed vessel, due to the weight of the bight under water; and the relieving ship is forced to approach the towed ship dangerously close in order to pick up the cask. Again, if the water is shallow the bight of the tow line is in danger of fouling on some object on the bottom. Because of these considerations the above method was not essayed by the *Cushing*, but another one more seamanlike, safer, and involving no cessation of towing, was successfully tried. It was as follows. The *Cushing* held her course, towing the *Murray*, while the *Dreadnought*, the relieving tug, steamed abreast of her, close aboard and at the same speed. One end of a five-inch line was led in through the stern chock of the *Cushing* and secured to the eight-inch tow line. The other end was led forward, outboard of everything, to the forecastle, where an ordinary heaving line was bent to it. Men stationed at intervals along the deck held the five-inch line. This having been done, the heaving line was shot across to the tug. Thereupon the tow line was let go by tripping the pelican hook, and the men who held the five-inch line threw it clear. A few minutes sufficed for the *Dreadnought* to slow down and haul aboard successfully the messenger, the five-inch line and the large tow line. The *Cushing* proceeded to Brest.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

REBUILDING THE NAVY'S ENLISTED PERSONNEL AND REESTABLISHING ITS MORALE AND SPIRIT

By Lieut. Commander J. C. Thom, U. S. Navy

The Situation To-Day

The navy is approximately 40,000 men short of authorized enlisted strength.

Enlistments are barely keeping pace with discharges and disenrollments.

Eighty-five per cent of enlistments are for two years.

Reenlistments are so few as to be negligible.

The navy is rapidly losing all of the older, trained, and experienced enlisted men.

Ninety per cent of the present enlisted force are young and inexperienced recruits, possibly good material, but woefully lacking in training, initiative, judgment, and physical development.

More than fifty per cent of commissioned line officers have been commissioned since the declaration of war, either from the Naval Academy, from the ranks, or from civil life, and these officers are generally unfamiliar with prewar conditions, standards, and training methods.

The prewar chief petty officer, the backbone of the enlisted personnel, has vanished. He is either an officer or a civilian.

The present chief petty officer, while representing the best among the present enlisted force, is inferior to his prewar predecessor by reason of lack of experience and training, and is therefore less competent to train recruits.

The Problem

How are we to rebuild the enlisted personnel, reestablish its morale and spirit, and regain the high standard of efficiency which existed in the forecastle prior to the declaration of war?

A SUGGESTED SOLUTION

Any innovation, however logical, is sure to meet with opposition. Naval officers are human, and when once established, they dislike any disturbance of their daily routine. It is not expected that these suggestions will meet with any marked approval from the forecastle, the steerage, the fourth ward, or the heads of departments. However, all hands will admit that something must be done, and the plan proposed herein, though it may never be adopted, may well be of value in causing a certain amount of thought, discussion, and protest, which may result in a better solution for the problem.

In this discussion the suggestions are made with reference to the deck divisions of the larger ships. Certain modifications will be necessary to suit conditions in other branches, and on smaller ships.

It is an acknowledged fact that the older and more valuable enlisted men can be retained in the service only if the present Congress provide for an adequate increase in pay.

Assuming that Congress will increase the pay of enlisted men, we must also assume that the Bureau of Navigation will offer all legal inducements to persuade ex-service men to return to the service. It is to be hoped that many will reenlist; but even the most optimistic among us must admit that a great many, and among them must be numbered some of the most valuable men, will have become established in civil life, with family and business ties which they will not care to break for the rather doubtful advantage of retaining their continuous service status.

At present we can expect that but a small percentage of the total enlisted personnel will be "old timers," men with two or more enlistments in the service. In fact, the great majority of the enlisted force will be recruits. Even those men who have been in for as much as two years are, in a sense, recruits, for conditions in the service since demobilization began have been such as to preclude any thorough training of recruits, and the rapid loss of the older men has deprived the navy of the valuable services of experienced instructors, who were so largely responsible for the efficiency of the prewar enlisted personnel.

It is not intended to infer that the prewar enlisted man received all his training at the hands of his petty officers. All drills and exercises were, of course, directed by officers, and

officers were likewise largely responsible for the efficiency, or the lack of efficiency, of their divisions as a whole, and of such drill units as gun and boat crews. Nevertheless, it is true that by no means all of the training of enlisted men was received during the periods between drill call and retreat. On the contrary the prewar recruit acquired a great part of his more intimate training and the greater portion of his knowledge of practical seamanship, from his association with the older enlisted men, the ship's petty officers. These experienced men were in great measure responsible for the transforming of recruits into sailormen. Their hours of instruction were not confined to drill periods. They taught by precept and example during the hours devoted to ship's work, to drill, and to play. They were the real backbone of the enlisted personnel and their loss cannot be overestimated.

It is obvious, therefore, that a great deal of the training of recruits must devolve upon the officers and particularly upon those who are now watch and division officers and junior officers.

Unfortunately, practically all of these younger officers are as lacking in experience and training as are the present day petty officers. Study the roster of officers of a modern battleship of the fleet. The senior watch officer is a lieutenant of the Naval Academy class of 1916. In prewar days he would be a junior lieutenant of less than one year. Practically all of the remaning watch officers are reserves, temporary regulars, or the product of the wartime three-year dash at the Naval Academy. They have been at sea, as officers, three years or less; have had no experience with prewar methods, standards, or requirements; and have, through no virtue of their own, been hoisted into billets beyond their capacity—which capacity is, except in rare cases, the product of experience and training alone.

No reflection on these officers is intended. They are of the identical breed, and potentially the same, as their older brothers in the service. It is an indisputable fact, however, that an officer with two years' sea experience cannot be expected to handle a division or take a watch as efficiently as an officer with six or eight years at sea.

A good watch and division officer is the product of experience, training, study, and observation. Like wine, he improves with age, and few of the older officers of to-day will say that when they

graduated from the watch officer class they had no more to learn about that important duty.

The average Naval Academy graduate has had practically no experience in handling men; and has but the vaguest conception of his duties and responsibilities. If he is taken fresh from his school books, thrust into an officer's uniform with two stripes upon the sleeve, and given a watch and a division, the transition is likely to be too swift for his abilities and his character to keep pace. The sudden increase in rank has been known to cause inflation of the ego, and the change from the rôle of midshipman with attendant restrictions, to that of lieutenant with corresponding authority, often results in the overdevelopment of such qualities as arrogance, indolence and "tougeness."

"As the twig is bent so is the tree inclined." Failure on the part of the older officers in the service to correct any wrong tendencies and impressions on the part of the new fledged younger officers may result, at a later day, in injustice to these officers and to the service.

Since we must rely upon officers for much of the training of recruits that was formerly done by experienced petty officers, and since, in general, the division officers of to-day are proportionately as deficient in training and experience as are the present day petty officers, our first step in rebuilding the enlisted personnel must be the inauguration of a rigid system of training for the younger officers.

If we adopt such a system and carry it out conscientiously, we will, while designedly improving the efficiency of our officers, be simultaneously training our men, for the reasons that if, as an item in his own training, a division officer is held responsible for the appearance of his men and their conduct at drill, he will soon take steps to see that they are above reproach. Of course, an officer is now presumably held responsible for any irregularities on the part of his men, when such irregularities are brought to the attention of the proper authorities. In the past, however, heads of departments have not ordinarily called the attention of the executive or of the division officers to minor infractions, it being generally considered that such action savored of officiousness or of tale bearing. It is, therefore, proposed to assign older officers to specific duty as "trouble hunters" who shall be constantly on the watch for irregularities in order that the attention

of younger officers may be called to errors in method and practice. It is proposed that temporarily the heads of departments on board ship be designated as "discipline officers"—for lack of a better name— and that these officers be charged with the responsibility of correcting the faults of the younger officers, training these officers in their professional duties, and particularly in discipline and the art of handling men.

To-day the shortage of men and the inefficiency of enlisted personnel keeps the greater number of battleships tied up at the yards. The prewar exercises and maneuvers are largely abandoned. The time which was formerly devoted to these drills and exercises may now be most properly employed in a period of intensive training of officers and men. And as the younger officers and the enlisted men are to be the victims of this proposed system, it is proper that the older officers devote their time and energies to the task of instructing and training their less experienced shipmates.

To the average naval officer the subject of classes and schoolrooms is abhorrent. Few will accept with alacrity the combined rôle of pedagog, drillmaster, boatsmain's mate, and master-at-arms. With efficiency and morale in the navy at the present low ebb heroic measures are necessary and every officer who desires to see a return to prewar conditions, should be willing to sacrifice a portion of his time and of his comfort to accomplish this result.

Since innovations are unpopular, the plan suggested herein if pursued perfunctorily and as an unpleasant extra duty, will be of little value. It is proposed that the system be made strenuous and exacting at the outset, and that it be given precedence over routine port drills and ship's work. It is proposed that division officers, junior officers, and men be on the job and on the jump from all hands until the end of working hours; that drills and exercises be long enough to be of real benefit but not so long as to become excessively monotonous; and that every drill and every exercise be conducted under the personal supervision of an older officer strictly charged with the duty of correcting errors, enforcing discipline, and requiring on the part of every officer and man concerned, strict attention to the job.

It is proposed that the discipline officers devote their attention chiefly to the officers, but at the same time hold these officers

responsible for the conduct, deportment, bearing, and efficiency of their men. In this way the discipline and training which is forced upon the officers will be communicated by them to their men, which is the ultimate result desired.

As an example of an average day it is suggested that reveille be not later than 5.30 a. m. and that all division officers be required to turn out at this hour and report to their parts of the ship to oversee the work of their divisions. It is further suggested that the discipline officer having the day's duty be on deck during this period for the purpose of supervising the activities of all divisions and of the officer of the day.

Breakfast should be at 7, and at 7.45 all hands should turn to, all division officers being present, to clean up ship for quarters; division officers should muster and inspect their divisions at 8.15 and report them at quarters at 8.30, at which time discipline officers should inspect divisions and part of the ship.

From 8.40 to 9 there should be a brisk physical drill which should be conducted in person by division officers, under supervision of discipline officers, and performed by all officers attached to divisions.

From 9.05 to 10.30 there should be a snappy infantry drill, including physical drill with arms, instruction and drill in the salute with and without arms, etc. This drill should be personally supervised by the discipline officer detailed for this duty, and division officers should never be allowed to take out or send out their divisions for individual drill, except under his supervision. The supervising officer should himself drill the divisions as a battalion, and should in addition, require individual company drill, during which he should correct irregularities in bearing, manner of giving and of executing commands, etc. These drills should be made as snappy as possible. When available a band should be present. It is an accepted fact that nothing improves a man's military appearance, manner, and bearing as much as a thorough course of correctly administered military drill, and for this reason it is proposed to make this drill a daily affair and to lay particular stress upon the necessity for strict attention and proper performance on the part of all concerned.

Retreat from this drill should be sounded at 10.30, followed by a fifteen minute "breathing spell" before battery drill at 10.45. This drill should occupy the period from 10.45 to 11.30

and should be devoted to testing out fire-control and communication systems, followed by a short period of drill for pointers and loading crews.

The afternoon drill period should begin at 1 p. m. and should be devoted to infantry, artillery, or boats under oars or sail. Retreat should be sounded at 2 and from 2.15 to 3 should be held school for officers, at which time lectures should be given by heads of departments to division and junior officers on subjects of professional interest. During this period the men would engage in ship's work or drills under the supervision of division petty officers. At 3.10 should be held school for enlisted men, under the instruction of division officers, and under the supervision of discipline officers. Twice a week this period should be devoted to inspecting bags or bedding, both operations to be under supervision of a discipline officer. Retreat should be sounded at 3.55. Night drills should be held twice weekly, all division officers being present.

The outline above is merely a suggestion and will of course require modification to suit particular conditions on individual ships. It is intended to indicate the amount of daily attention to, and supervision over, the activities of division and junior officers which should be exercised by discipline officers.

All officers who graduated from the Naval Academy in 1917 or later and all officers who have been commissioned from other sources since that date, should be required to keep journals in which should be written each week an article, essay, description, etc., on some subject of interest to the naval service. These journals should be rigidly examined by a discipline officer and marks assigned. Should a journal prove unsatisfactory the owner should be required to submit additional work.

During the period of intensive training, routine ship's drills should be reduced to a minimum. However, particular attention should be paid to the conduct of officers and men at these drills. Instruction in bugle calls and pipes should be given until all officers and men are thoroughly familiar with them, and with the fact that each call for drill, boats' crews, etc., is a signal for some one to step out on the double. This should be strictly enforced with officers and men.

In order to carry out this or a similar plan it is proposed that the heads of departments and other officers, preferably lieutenant

commanders or above, be detailed as discipline officers for the training and instruction of division and junior officers, and to supervise these officers in their work as watch and division officers. These discipline officers should be assigned according to their qualifications, or their duties, somewhat as follows:

Executive: General supervision of all drills and instruction. Responsible for preparation of drill schedule and for assignment of discipline officers.

Navigator: In charge of schools for enlisted men of deck force, and of lectures for officers. In charge of officers' journals and note books.

Engineer: In charge of schools for enlisted men engineer force, and of junior engineer officers' journals and note books. General supervision of drills and inspections of engineer divisions.

Ordnance: In charge of infantry, artillery, and gunnery drills.

First Lieutenant: In charge of emergency drills, physical drill, boat drill.

The executive officer should prepare a comprehensive schedule of drill, instruction, and ship's work, so varied as to reduce monotony, but arranged to cover the entire working day, with fifteen minute "breathing spells" in forenoon and afternoon. He should assign as discipline officers his heads of departments either as outlined above, which outline is based on the duties performed by these officers, or according to the particular abilities or preferences of the officers concerned.

The navigator should have charge of instruction of enlisted men, the actual instruction to be performed by division officers. He should arrange a schedule for approval by the executive, and personally supervise all classes in order to assure himself that this schedule is properly carried out and not in a perfunctory and dilatory manner. This instruction should be confined to purely practical subjects such as seamanship, gunnery, primary navigation, signals, radio telegraphy, naval regs., naval etiquette, customs and traditions, military law, etc. Instruction in academic subjects and specialties should not be included but should be given in special classes upon request.

He should also have charge of the instruction of division and junior officers should arrange for lectures on naval and allied

subjects by officers from his own and other ships, and by civilian specialists when practicable.

He should have charge of officers' journals and note books; should require diligent and conscientious work in these journals, and should, if necessary, assign subjects to be investigated and written upon by officers. He should carefully examine these journals and assign marks, requiring officers whose journal work is unsatisfactory to submit additional work.

At sea, and when practicable in port, he should require officers to perform a reasonable amount of navigation work and should correct all navigation notebooks.

The engineer officer should exercise similar supervisory duties in connection with the school for enlisted men of the engineer force, conducted by the junior engineer officers. He should prepare schedules of instruction and see that these schedules are properly followed. He should, in addition, exercise personal supervision over the drills and inspections of the engineer divisions, and should assign notebook subjects to junior engineer officers, which work he should examine, correct, and mark.

The ordnance officer should have charge of all gunnery, infantry, artillery, and similar drills. If necessary he may be assisted by other officers, such as assistants to heads of departments. He should prepare a schedule of his drills for approval by the executive, and should personally supervise and direct such drills. His paramount duty should be the instruction of division officers in their duties in connection with these drills, and the correction of errors of officers in manner of giving and of executing commands, military bearing, rendering salutes, naval phraseology, attitude toward enlisted men, and toward other officers. The first lieutenant should have charge of all emergency drills, physical drill, and boat drills. His particular interest should be the instruction of officers in the proper stationing and handling of their men, and in the proper deportment of officers and men at drill. He should require all officers to move at the double during emergency drills, and to take part in all physical drills. He should instruct officers in the proper handling of boats under sail and oars, and in the proper method of giving commands for boat evolutions. He should cause to be submitted to him all division watch, quarter, and station bills, and division

books, which he should require to be kept up to date and in approved form.

In addition the discipline officer having the day's duty should supervise bag and bedding inspections, and require division officers to correct all faults.

It should be impressed upon all discipline officers that they are strictly charged with the duty of instructing watch officers in the proper method of standing watch on deck or on the bridge, and that they are required to correct any faults of bearing, deportment, or language on the part of the officer of the day which may come to their attention.

To be of any value this, or any similar system, of intensive training must be relentlessly prosecuted. No errors due to ignorance, indifference, carelessness, or any other cause, should be overlooked. Discipline officers should, from the first, take subordinates to task for all irregularities however slight, of conduct, bearing, manner or giving and executing commands, attitude toward enlisted men and toward other officers, personal appearance, and for all irregularities on the part of their men. Until the present slackness and inefficiency is largely corrected exaggerated disciplinary measures should continue in force until sufficient improvement is visible to warrant gradual modification. Return to normal conditions should depend upon the results obtained and should be a goal for which the chief sufferers, junior officers and men should strive.

In conclusion, the present lack of efficiency and morale can be remedied only by a radical change in training methods. Nothing suggested above is new. Everything has been tried out in the past to a greater or a lesser degree. It is merely proposed to combine various disciplinary and instructional features in one program of intensive training, the primary object being the development of the efficiency of the junior half of the officer personnel; and the ultimate aim the training of the enlisted men, and of the entire service. It is not expected that these suggestions will be adopted, but it is hoped that they may cause some constructive criticism from which a better plan may be evolved.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.
[COPYRIGHTED]

LINE OF POSITION BY AZIMUTH OBSERVATIONS

By A. B. CLEMENTS

The navigator has from earliest days depended upon measurements of the altitude of heavenly bodies. At first the latitude alone was calculated, then, with the improvement in time-keepers, the longitude also could be obtained. The latitude was for so long a time all that could be determined that it got to have a peculiar value to navigators, and even after it became possible to obtain the longitude, it was supposed to be more dependable than the longitude though the latitude were itself obtained by methods depending upon time, as the reduction to the meridian and single altitude at a given time. In recent editions of Bowditch it is advised that the computed point on the line of position be disregarded in favor of one depending on the dead reckoning latitude, though the computed point is nearer the dead reckoning position than the one recommended and is in a popular sense the "most probable" position. So since the navigator has so long depended upon the measurement of the altitude, he has ignored the possibility of obtaining his position by any other measurement. He has computed his position at sea from a solution of the astronomical triangle using as known quantities the declination obtained from the Nautical Almanac, the altitude, obtained by a measurement with the sextant, and assumed values of either or both the latitude and longitude. The perfection of the circle of reflection and sextant, and the accuracy of observations with them when the horizon is visible, has made this method most satisfactory. The fact that measurements of either of the remain-quantities, if possible, would be equally valuable to him and equally enable him to solve the astronomical triangle and obtain his position is seldom considered, though occasions often arise at

sea where measurement of the altitude with accuracy is impossible and that of the azimuth is practicable and convenient.

There is no way of measuring the position angle of a celestial body, but the corresponding angle of a radio compass station on shore is now furnished by radio compass stations along the coast, and vessels are constantly navigating the coasts of the United States, Great Britain and France, using positions obtained by computation or plotting from these angles. An article on the determination of positions by radio compass azimuths and position angles was published on the back of the Pilot Chart for the North Atlantic for January, 1920, reprints of which may be obtained from the Hydrographic Office, Navy Department.

Little attention has been paid to determining positions by measurement of the azimuth of heavenly bodies, though with the improved forms of the azimuth circle the azimuth may be determined with accuracy. The navigator is often able to see the sun or stars overhead when the horizon is entirely obscured by fog, and many devices have been suggested for determining the horizon or a substitute for the horizon so that sextant altitudes can be measured, and thus the method of solution of the astronomical triangle based on the knowledge of the altitude be used. In such cases it is generally possible to obtain fairly accurate measurements of the azimuth and from a solution of the triangle with the azimuth as a known part obtain points on the line of position more accurately than they could be obtained by computation based on sextant observations of the altitude with uncertain position of the horizon. While the azimuth method is not nearly so accurate as the altitude method, the error of the azimuth method is least when the altitude is great, and as bodies high in altitude are the only ones plainly visible in fog, it is at this time when the usual method fails entirely or is at its worst that the azimuth method is at its best. In the examples given dotted lines are plotted showing the errors in the lines of position due to an error of one degree in the determination of the azimuth.

Since the line of position determined by an observation of the azimuth makes a large angle with the line of position obtained from an altitude of the same body, the two lines may be combined with advantage. As these lines of position are absolutely independent of each other, the position of their intersection is a

legitimate fix, subject only to the errors of the two observations. This method of obtaining a fix may be of great value where for any reason the position of the ship is uncertain and an immediate, even if only approximate, fix is desired.

A convenient method for the computation of points on the line of position by the azimuth method, whether the observed body be a wireless station on shore or a celestial body, is as follows:

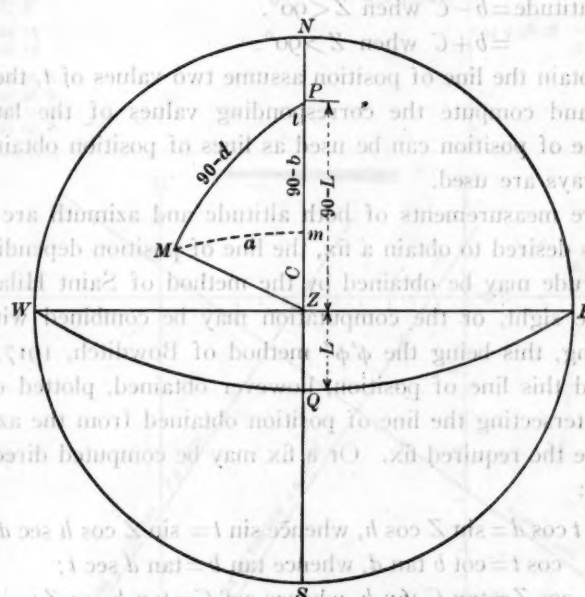


FIG. 1.

Let Fig. 1 be a projection of the celestial sphere on the plane of the horizon.

Z, the zenith of the observer.

P, the elevated pole.

M, the observed body or the zenith of the wireless station on shore.

Mm, the perpendicular from *M* on the meridian of the observer. Then, calling *Mm*, *a*, the length of the perpendicular,

Qm, *b*, the latitude of the foot of the perpendicular,

Zm, C, the zenith distance of the foot of the perpendicular, from Napier's rules.

$$\text{Cos } t = \cot b \tan d, \text{ whence } \tan b = \tan d \sec t; \quad (1)$$

$$\cos b = \tan a \cot t, \text{ whence } \tan a = \cos b \tan t; \quad (2)$$

$$\sin C = \cot Z \tan a; \quad (3)$$

and substituting for $\tan a$ from (2) in (3)

$$\sin C = \cot Z \cos b \tan t, \quad (4)$$

and latitude $= b - C$ when $Z < 90°$.

$= b + C$ when $Z > 90°$.

To obtain the line of position assume two values of t, the hour angle, and compute the corresponding values of the latitude. This line of position can be used as lines of position obtained in other ways are used.

Where measurements of both altitude and azimuth are made and it is desired to obtain a fix, the line of position depending on the altitude may be obtained by the method of Saint Hilaire or the time sight, or the computation may be combined with the foregoing, this being the $\phi'\phi''$ method of Bowditch, 1917, page 134, and this line of position, however obtained, plotted on the chart intersecting the line of position obtained from the azimuth will give the required fix. Or a fix may be computed directly as follows:

$$\sin t \cos d = \sin Z \cos h, \text{ whence } \sin t = \sin Z \cos h \sec d; \quad (1)$$

$$\cos t = \cot b \tan d, \text{ whence } \tan b = \tan d \sec t; \quad (2)$$

$$\cos Z = \tan C \tan h, \text{ whence } \cot C = \tan h \sec Z; \quad (3)$$

and latitude $= b - C$ when $Z < 90°$

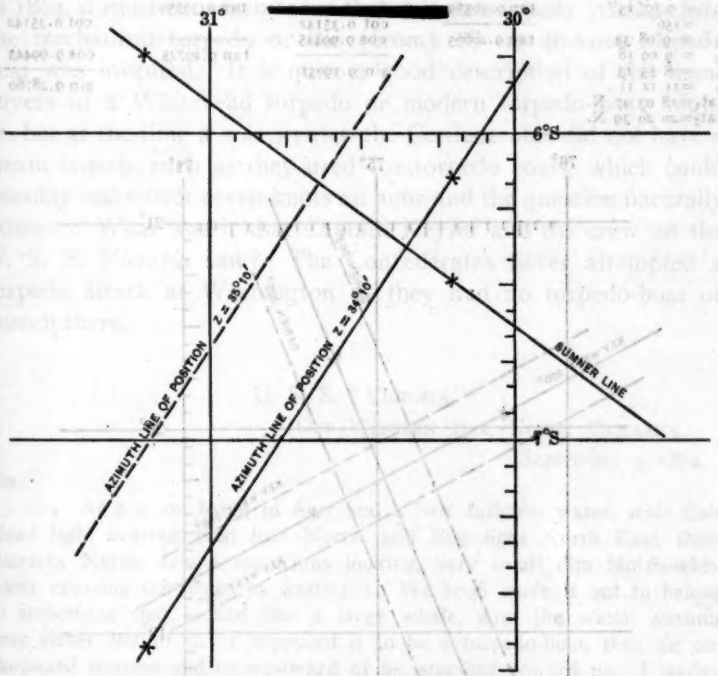
$= b + C$ when $Z > 90°$.

The labor of the computations required in the use of these formulæ as well as in other calculations of navigation involving the solution of a spherical triangle may be avoided by the use of a table of right spherical triangles such as that published by the Navy Department in Hydrographic Office Publication No. 200, Table VI. A larger table that would not necessitate interpolation or corrections is much to be desired. Though such a table would be bulky and contain many pages "It is easier to turn pages than it is to interpolate."

Example 1.—October 10, 1916, 3 p. m., in dead reckoning latitude 6° 21′ S., longitude 30° 21′ 30″ W. At Greenwich mean time $12^h\ 43^m\ 32.5^s$ observed azimuth of moon's center N. 34° 10′ E. and corrected altitude 70° 11′ 03″. The declination is found to be 10° 03′ N. and the Greenwich hour angle $1^h\ 16^m\ 51.3^s$ W. (19° 12′ 49.5″ W.).

ASSUMING LONGITUDES 30° 12′ 49.5″ W. AND 31° 12′ 49 5″ W.

	AZIMUTH LINE OF POSITION				$\phi'\ \phi''$ LINE OF POSITION	
l_1 =11° E.	sec 0.00805	tan 9.28865				
l_2 =12° E.			sec 0.00960	tan 9.32747		
d =10°03 N.	tan 9.24853		tan 9.24853		cos 0.75819	cos 0.75819
z =34°10′		cot 0.16829		cot 0.16820		
h =70°11′03″					sin 9.97349	sin 9.97349
b_1 =10°14′ 02″	tan 9.25698	cos 9.99304			sin 9.24960	
b_2 =10 16 12			tan 9.25813	cos 9.99299		sin 9.25112
c_{1s} =16 22 08		sin 9.44998				
c_{2s} =17 56 50				sin 9.48875		
c_{1h} =16 42 15					cos 9.98128	
c_{2h} =16 01 15						cos 9.98280
L_{1s}= 6 08 06 S.						
L_{2s}= 7 40 38 S.						
L_{1h}= 6 28 13 S.						
L_{2h}= 5 45 03 S.						



DIRECT COMPUTATION FROM OBSERVED ALTITUDE AND AZIMUTH

d	=10°03′ N	sec 0.00672	tan 9.24853	
z	=34 10	sin 9.74943		sec 0.08228
h	=70 11 03	cos 9.53019	tan 0.44329	
t	=11°08′ 53″	sin 9.28634	sec 0.00828	
b	=10 14 22		tan 9.25681	
c	=16 35 51			cot 0.52557
Lat	= 6 21 29 S.			
Long	=30 21 42.5 W.			

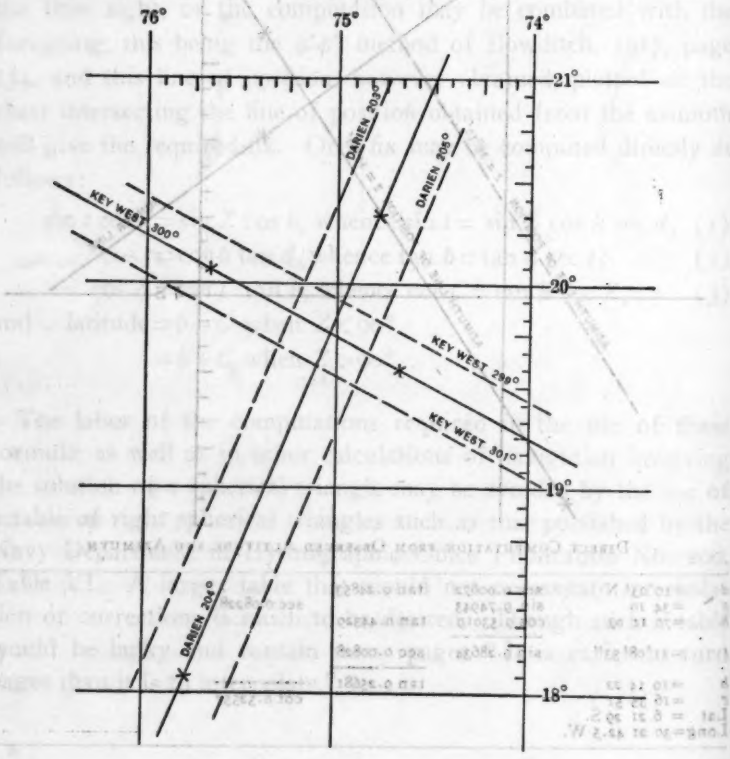
Example 2.—In dead reckoning latitude 19° 31′ N., longitude 75° W. observed radio compass bearings Key West 300° and Darien 204° Position Wireless Station, Key West, latitude 24° 32′ 48″ N., longitude 84° 39′ 52″ W. Position Wireless Station, Darien, latitude 9° 07′ 15″ N., longitude 79° 46′ 20″ W.

FOR KEY WEST LINE ASSUME LONGITUDES 75° 39′ 52″ W AND 74° 39′ 52″ W.

t_1 = 9°	sec 0.00538	tan 9.19971			
t_2 = 10			sec 0.00665	tan 9.24632	
d = 24 32′ 48″ N.	tan 9.65964		tan 9.65964		
z = 60		cot 9.76144		cot 9.76144	
b_1 = 24 48 58	tan 9.66502	cos 9.95792			
b_2 = 24 52 47			tan 9.66629	cos 9.95770	
c_1 = 4 45 40		sin 8.91907			
c_2 = 5 17 57				sin 8.96546	
Lat_1 = 20 03 18 N.					
Lat_2 = 19 34 50 N.					

FOR DARIEN LINE ASSUME LONGITUDES 75° 46′ 20″ W. AND 74° 46′ 20″ W.

t_1 = 4°	sec 0.00106	tan 8.84464			
t_2 = 5			sec 0.00166	tan 8.94195	
d = 9 07′ 15″	tan 9.20559		tan 9.30559		
z = 136°		cot 0.35142		cot 0.35142	
b_1 = 9°08 34	tan 9.20665	cos 9.99445			
b_2 = 9 09 18			tan 9.20725	cos 9.99443	
c_1 = 8 55 13		sin 9.19051			
c_2 = 11 11 11				sin 9.28780	
Lat_1 = 18 03 47 N.					
Lat_2 = 20 20 39 N.					



[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MYSTERIES OF THE SEA

By James Morris Morgan

In reading the following official report of the captain of the U. S. S. *Victoria,* one of the blockading fleet off Wilmington, N. C., in 1864, it must be remembered that it is dated many years before the mechanical torpedo or the (from) 18- to 40-knot torpedo boat was invented. It is quite a good description of the manœuvers of a Whitehead torpedo or modern torpedo boat might be, but at the time it was written the Confederates did not have a steam launch, such as they used for torpedo boats, which could possibly make over seven knots an hour and the question naturally arises: "What was it that Captain Keyser and the crew on the U. S. S. *Victoria* saw? The Confederates never attempted a torpedo attack at Wilmington as they had no torpedo-boat or launch there.

U. S. S. "Victoria,"[1]
Off Western Bar, North Carolina,
September 9, 1864.

Sir:

. . . . At 2 a. m. being in four and a half fathoms water, with Bald Head light bearing East half North, and Bug light North East, three quarters North, saw a suspicious looking, very small dim bluish-white water crossing our stern to westward. We soon made it out to belong to something that looked like a large whale, with the water washing over either end of it. I supposed it to be a torpedo-boat, then on our starboard quarter and to westward of us, standing toward us. I started ahead on one bell to bring our starboard broadside gun to bear upon him (the pivot gun cannot be used in broadside) and fired as soon as possible: then started full speed in order to change our position and avoid his blow under cover of the smoke. I then stopped and looked for him

[1] See U. S. Naval War Records, Vol. 10, p. 447.

again. He soon after made his appearance upon our starboard quarter, as before. Not having room to turn my broadside to him, I started, as we headed East South East: full speed to gain room, but he ran parallel to us and as fast as we could go. I then rang one bell, which soon brought him abeam, fired starboard gun again, and went full speed. Having more steam by this time, we easily distanced him and got, as I thought, off shore of him in the smoke and lost sight of him. I then stopped and watched for him. In about fifteen minutes he appeared upon our starboard side, two points forward of the beam. We then started full speed, fired our starboard gun at him, put our helm hard aport, and in the smoke got to westward of him by crossing his stern (I did not expect to strike him before we got around). I stood out in eight fathoms in order to have more room if he tried us again: stopped and set red and blue light at the peak. In about twenty minutes saw him again on port quarter, turned the ship toward him until he was abeam, fired port broadside gun at him. I think and so did all the officers, that the last shot struck him, as he was very near, say forty yards, and the gun was fired with an aim. All the others were pointed with the helm, as he could not be seen from the main deck, it being very dark . . .

Fired in all five shots: our guns were loaded with shell and grape over them. Wind NNE. very light, and water very smooth.

I am very respectfully
Your obedient servant,
(Signed) E. S. KEYSER,
Acting Master Commanding.

Captain B. F. Sands,
Divisional Officer,
Off Western Bar, N. C.

DISCUSSION

On the Importance of Leadership

(See Page 335, Whole No. 205)

Rear Admiral Caspar F. Goodrich, U. S. Navy.—Owing to my absence in the Far East, the March number of the Institute's Proceedings has but recently come into my hands, hence this belated appreciation of a most admirable article by Captain Knox.

Supplementary to his remarks, which deal chiefly with instruction and study in the matter of leadership, I would like to suggest that something may be done in actual training for command. It is threshing out old straw, I admit, but I cannot lose so good an opportunity as this to deplore the denial to all, except a favored few in each class at the Naval Academy, of exercise in this art. Many graduates hear their voices in giving orders for the first time on going on board a ship. This is regrettable and avoidable. Is it fair? Upon what grounds can it be justified?

The cadet offices at Annapolis should not be permanent. They should be assigned *absolutely by lot* and transfers made once a month, or more or less often as may be necessary to give every man in the first class a trick as commissioned officer in the battalion. Luck alone will then determine whether he occupy for the nonce the exalted position of regimental commander. In this way all suspicion of favoritism will be eliminated and every member of the graduating class will make his own record in displaying officer-like qualities to which a proper multiple ought be given in fixing his final order of merit. The Academy teaches everything needed except this one thing, how to lead men. One would suppose it more important to young officers than any technical branch.

That the battalion's drills would suffer by not having permanent cadet officers is a mere supposition, a begging of the question. Personally I believe there is no chance whatever for such an outcome and I base my belief upon facts and experience, not upon theory. The plan suggested I tried in the Princeton Naval Unit. It worked to perfection and, in addition, every man in the unit was convinced that I had no favorites; that all stood on the same level and had equal opportunities for giving orders and seeing that they were obeyed. It is impossible to exaggerate the keenness with which these young men fitted themselves for their new duties as cadet officers or the thoroughness with which they lent all their energies, even when demoted, to maintaining the morale and smartness of drills of the corps. Under such a practice there could be and there was no dissatisfaction. Disappointment? Yes, but for that no one was to blame. The fickle goddess, Chance, alone was answerable.

DISCUSSION

On the Importance of Leadership

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

Membership

Life, regular and associate membership, 5290.
New Members: 10. Resignations: 4. Dropped: 169. Deaths: (3)
Rear Admiral E. H. Gheen, U. S. Navy,
Commodore Jas. T. Smith, U. S. Navy,
Mr. Chas. M. Howe.

Dues

The annual dues ($3.00) for the year 1920 are now payable.

Regular and associate members of the U. S. Naval Institute are subjected to the payment of the annual dues until the date of the receipt of their resignation.

Address of Members

All members are urged to keep the Secretary and Treasurer informed of the address to which PROCEEDINGS *are to be sent, and thus insure their receipt.*

Members and subscribers are urged to notify the Secretary and Treasurer promptly of the non-receipt of PROCEEDINGS, in order that tracers may be started. The issue is completed by the 15th of each month.

Book Department

The Institute Book Department will supply any obtainable book, of any kind, at retail price, postage prepaid. The trouble saved the purchaser through having one source of supply for all books, should be considered. The cost will not be greater and sometimes less than when obtained from dealers.

Reprints of Articles

The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article

is submitted. Twenty copies of reprints are furnished authors free of charge.

Illustrations Authors of articles submitted are urged to furnish with their manuscript any illustrations they may have in their possession for such articles. The Institute will gladly co-operate in obtaining such illustrations as may be suggested by authors.

Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Notice Whole Nos. 6, 7, 10, 13, 14, 15, 17, 144, 145, 146, 147, 149, 155, 167 and 173 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 75 cents per copy.

ANNAPOLIS, MD., September 15, 1920.

INFORMATION INDEX

PAGE
ADVERTISEMENTS, INDEX TO 1
PUBLICATIONS, U. S. NAVAL INSTITUTE ..... (2)
SPECIAL NOTICE 1712
TOPICS FOR ESSAYS 1713
LIST OF PRIZE ESSAYS 1715

PROFESSIONAL NOTES

PREPARED BY

LIEUT. COMMANDER H. W. UNDERWOOD, U. S. Navy

GENERAL ARRANGEMENT

VESSELS BUILDING. } France 1649
NAVAL POLICY. } Germany 1652
MATÉRIEL. } Great Britain 1655
PERSONNEL. } Japan 1659
MERCHANT MARINE. } United States 1661
AERONAUTICS 1681
ENGINEERING 1683
ORDNANCE 1685
NAVIGATION AND RADIO 1689
MISCELLANEOUS 1692
CURRENT NAVAL AND PROFESSIONAL PAPERS 1695

FRANCE

FRENCH NAVAL PROGRESS.—The voting of the Marine Budget by the two Chambers has shown that the Senate is at one with the Chamber in urging the prompt taking in hand of an enlarged shipbuilding and aerial program worthy of France's past traditions and present responsibilities. Senator Berenger called attention to the growing competition of naval armaments that were themselves the expression of economic rivalry, and hinted at possibilities of the near future which France could not afford to ignore. Whilst having neither the wish nor the means of competing with her great allies, France owes it to herself as well as to her friends to remain a determining factor at sea and to make the most of her unique strategic assets for the defence of her vital interests. She must ever remember that the million troops she could raise in her colonies and the unlimited supplies she could draw from the same sources—and that would be vital assets against Germany—would be of no account whatever, but rather a ransom in the hands of her enemies, without the support of an adequate fleet at all times in a position to maintain safe communications by sea. Therefore the absolute naval command of the Western Mediterranean, together with the undeferred organization of a reliable trans-Mediterranean flying service, must be the basis of the French naval policy, which means—remembering the *Goeben-Breslau* affair—that the Republic cannot safely allow any continental power to eclipse her in the matter of speed and calibers. With these views, that were supported by the unanimity of the Senate, Minister Landry concurred, and announced that the 1921 Budget now under preparation would mark a first and vigorous step towards the expansion of the navy, and provide for super-scouts and aerial cruisers of bombardment.

Contracts are being awarded for six torpilleurs of under 1000 tons, to carry 4-inch guns and 22-inch torpedoes, intended for general duties off the coasts and with the fleet, as well as for six 2000-ton conducteurs d'escadrilles of 36 knots to mount 5.5-inch weapons, designed for high sea work with the cruiser divisions. The "fragilité excessive" of the destroyers of 800 tons, that has been denounced in the Chamber, is this time to be

avoided, the war having brought home to French naval men the value of robustness and of reliable sea speed. Similarly the new submersibles, made with the cooperation of private constructors, are to be freed from the notorious defects of the *Lagrange* type and to have reliability as their strong points.

The foresight of the British Admiralty in providing for an ample reserve of oil fuel for British ships is much admired and envied on this side, where governmental instability and traditional incompetence at the head do not permit the application of the old precept: *Gouverner c'est prévoir.* Oil fuel in adequate quantity has become the primary condition of sea and air power, and for the present at least France is badly handicapped in this respect, though bright hopes are entertained for the future. Under recent arrangements France is to receive 25 per cent of the production of the Mossul oilfields and of the Anglo-Persian Oil Co., but this source of supply is subordinated to the Franco-British alliance, and Gallic experts would like to be independent. Hence the efforts being made to develop the petroleum wealth of North Africa. The three zones of Algerian wells yield some 30 tons of oil per day, the rate of supply being relatively higher than is the case with either Rumanian and American wells. Preparations for the opening of petroleum wells are being made in Tunisia and Morocco, whilst Franco-British concerns are already tackling the problem of petroleum exploitation in Madagascar and Indo-China, where exist abundant oilfields. France is now suffering so very much from shortage of fuel that the administrative red tape that is peculiar to our Republican régime is not this time to be allowed to delay progress, and in a very few years there is a probability of our Republic being in possession of a fully-adequate oil supply of her own, a *fait nouveau* that will have far-reaching consequences in fighting efficiency and all-round maritime expansion. The unpalatable result of the actual fuel shortage may be gauged from the lamentations of a *vieil amiral* in a recent number of the *Moniteur de la Flotte.* French battleships are keeping to harbor for the sake of economy; *erreur fatale, conséquences incalculables,* jubilation among Toulon publicans and spirit dealers, but indignation and disgust on the part of thoughtful Frenchmen. The 24,000-ton Courbets are reproached with consuming one ton of coal per mile—*de l'argent en fumée,* as used to say the late Mons. Pelletan—but a *flotte immobile et stagnante* is nothing more than expensive make-believe that deceives no one. British squadrons, it is noted, are keeping in splendid trim, ever at sea, with motors and armament in perfect working condition; and even Italy, despite her slender resources, is straining every nerve to make her dreadnoughts and flotillas something more than a naval pretence. In truth, the situation is not quite so bad as depicted; new life is gradually being instilled into the flotillas that comprise newly-refitted destroyers and submarines, and the *Charlier* battleships are to test at sea their recent motor and ballistic improvements in combined maneuvers with the *Toulon* and *Bizerta* flotillas.

Investigations made by the Commission de la Marine point to a deterioration of the quality of the navy personnel as the consequence of injudicious recruiting and of disastrous blunders by the Leygues Administration. The seafaring Bretons, who formerly composed the bulk of the fleet and were a tried element of fighting strength, have been mostly replaced in the course of the last three years by 46,000 short-term volunteers (*engagés volontaires*), of whom it has been officially stated that 50 per cent remain *invinciblement refractaires à toute éducation maritime.* Happily this rabble in naval uniform that caused the Black Sea rebellion is to be completely cleared out of the service by the end of 1921, when the Gallic Navy will become anew a service of true seamen, fully alive to the grandeur of the maritime career and inferior to none in professional worth. The physical standard especially will be higher than at any previous time, as the result of the patriotic efforts of Minister Landry, who from the first grasped this capital fact, long realized in England, but ignored by his predecessors, that bodily

health and strength is the true foundation of fighting efficiency. Gold lace on blue sleeves does not make officers, that is, military leaders, but only the love of manly efforts, both physical and mental, since victory in war requires a full display of the noblest qualities, together with constant watchfulness and cheerful readiness to face any odds.

Such are the new ideas being inculcated in the *élèves de l'Ecole Navale* and naval cadets who last week landed at Lorient from the destroyer *Aventurier* (1000 tons, 30 knots), aviso *Meuse* (850 tons), and cruiser *Jeanne d'Arc* (11,000 tons, 21 knots) to witness at the *Ecole de gymnastique* a display of the novel methods of physical culture and to receive the explanations and commendations of Lieutenant Bonneau, who is continuing the remarkable work of Lieutenant Hébert in the physical training line. Henceforth, from *apprenti-marin* to admiral, the first duty of the Gallic seaman is, in the words of Herbert Spencer, to be a "fine animal," and, indeed, when past traditions are considered, it is not exaggerating to say that a new era is opening in French naval annals, due in a great part to British influence.

Whereas the physical standard of French naval officers was formerly rather low, owing to the absence of physical tests at the Ecole Navale, it is interesting to note that 10 per cent of the 1920 candidates have been rejected as being inferior to the required standard, though they had successfully passed through the competitive examination. This means something of a revolution. *Navale* is no longer to be the refuge of weedy youngsters unfit for St. Cyr. Under the new conditions greater physical endurance is required from naval officers than from army officers, and it is no secret that the war has seen occasional failings on the part of physically inefficient unit and group commanders.—*The Naval and Military Record*, August 4, 1920.

FRENCH SHIPBUILDING OUTLOOK.—In its economic survey of certain countries specially affected by the war at the close of the year 1919, the British Department of Overseas Trade has this to say of France's shipbuilding prospects:

"The merchant navy of France before the war numbered 1895 steamships and 15,824 sailing vessels with a gross tonnage of 2,535,775 tons. These vessels were manned by 98,730 men. Construction had proceeded, but slowly during the years previous to the outbreak of hostilities and the inferiority of France in comparison with the great trading nations had become more marked.

"In the years 1912, 1913 and 1914 she purchased in foreign countries 156 steamships and 18 sailing vessels with a tonnage of 211,757 tons. Yet even with this assistance she was outstripped by other countries. A detail of some interest is that the average tonnage of steamers constructed in France in the three years mentioned was 3040, 3410 and 4260 tons respectively, while that of the steamers purchased abroad was only 1560, 1030 and 1780. The result of the slow increase of French construction was that France became increasingly dependent on foreign bottoms, and that a large toll in freight had thus to be paid for the service rendered, which has been estimated at 500,000,000 francs.

"The situation has not improved. It is estimated that during the period of hostilities 961,621 tons were lost by enemy action, and 136,887 tons by the ordinary accidents of navigation. Shipping under the French flag was thus reduced to 1,457,267 tons. To replace these losses 227,000 tons are now building. An estimate of future construction which has been prepared by the competent department gives the following figures:

Year	No. of vessels	Gross tons
1920	159	605,665
1921	172	704,361
1922	176	765,377
1923	183	793,405

"A difficulty, which is a grave obstacle to the construction of merchant ships in France, is the high cost of raw material and in this respect the situation has become more difficult on account of the depreciation of the franc."—*The Nautical Gazette*, August 14, 1920.

GERMANY

"DEUTSCHLAND ZUR SEE."—Whilst the execution of the peace terms has deprived Germany of her most effective naval material, it is incorrect to assume that the German Fleet has entirely disappeared. A new fleet has already been formed, within the limits prescribed by the Treaty. The collection of vessels recently placed in commission is officially termed the *Reichs-Flotte*, but is sometimes referred to as the *Verteidigungs-Flotte*, or Defence Fleet. It may be recalled that the avowed object of the naval clauses of the Peace Treaty was to reduce German naval strength to the requirements of police and frontier control. The post-war fleet was therefore to contain no more than six battleships of the *Deutschland-Braunschweig* type, six light cruisers, 12 destroyers, and 12 torpedo-boats. With regard to the renewal of floating material, it was laid down that new vessels built should not exceed 10,000 tons for armored ships, 6000 tons for light cruisers, 800 tons for destroyers, and 200 tons for torpedo-boats, and unless ships were lost no *Ersatz* battleship or cruiser was to be built until the vessel it replaced was 20 years old, or, in the case of destroyers and torpedo-boats, 15 years old from the date of launch. The building or acquisition of submersible craft of any description was absolutely inhibited. The maximum strength of the personnel was fixed at 15,000, including officers and the staff ashore, and of this total not more than 1500 were to be officers and warrant officers.

Until quite lately it was widely supposed that Germany would not go to the trouble and expense of maintaining a properly-organized naval force, which, consisting only of out-of-date vessels, would have practically no defensive value. This expectation, however, has not been fulfilled. The latest news from Berlin shows that the full naval establishment authorized by the Treaty is now in being. There is some doubt as to the present condition of the six old battleships which have been commissioned. Most of them had been partially dismantled before the end of the war, their guns being taken for work at the front, and certain fittings and structural parts removed to be embodied in new submarines. Probably, however, all the six have since been refitted and rearmed. The oldest ship in the group is the *Braunschweig*, which was launched in December, 1902, and the youngest is the *Schlesien*, launched in May, 1906. Consequently in little more than two years from now Germany will be at liberty to lay down an *Ersatz* armored ship for the *Braunschweig*, and by 1926 she may be constructing new vessels in place of the entire six—always provided that the substitutes do not exceed 10,000 tons in displacement.

The six light cruisers of the post-war fleet are older even than the battleships, selected as they are from the best ships among the *Gazelle*, *Frauenlob*, and *Bremen* classes, dating from 1899-1905. As the oldest light cruiser, the *Amazone*, was launched in 1900, Germany will be free to lay down an *Ersatz* this year if she so desires; and whereas the *Amazone* is of 2,650 tons only, her successor may be anything up to a limit of 6000 tons, which is quite a substantial displacement for light cruisers. There would be no difficulty in building a cruiser of this size capable of steaming at 30 knots, with an extensive radius of action and a powerful armament. The 24 destroyers and torpedo-boats are mostly obsolete, but a few boats built in 1912-13 are included, these being about 600 tons, with an original speed of 32½ knots, and an armament of two 3.4-inch Q. F. and four 19.7-inch tubes. Some of the torpedo-boats now in commission are already eligible for replacement under the 15-year age proviso.

The following is a complete list of the vessels of the German *Reichsflotte* now in commission:

Battleships: *Schlesien, Schleswig-Holstein, Hannover, Hessen, Elsass, Braunschweig.*

Light cruisers: *Berlin, Hamburg, Arkona, Medusa, Amazone, Thetis.*

Destroyers: *G-8, G-10, G-11, S-18, S-19, V-2, V-3, V-5, V-6, T-185, T-190, T-196.*

Torpedo-boats: No. *99, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 113.*

It will be seen that the German Fleet as at present constituted, is really a coast-defence force, more to be compared with the navies of the minor European states than with those of the great powers. But it is large enough to be used for training purposes, and this no doubt was the German Government's principle motive for organizing a post-war fleet at all. Wilhelmshaven, it appears, is to remain the chief naval base, in spite of the "demoralizing atmosphere" which Admiral Hollweg declares to have prevailed there since the revolution. Apart from its obsolete material, the German Fleet of to-day is sorely handicapped by a shortage of efficient officers. According to Admiral Hollweg practically all the officers who remained with the fleet after the great collapse have since resigned, owing to their inability to preserve discipline. The seamen are said to have become incredibly lazy and insolent, and the ships and establishments at Wilhelmshaven are run more or less on Soviet lines. So long as affairs remain in this condition the service will offer no attraction whatever to officers of a desirable type. It remains to be seen whether the drastic measures which have kept the *Reichswehr* free from Bolshevist contamination will eventually be applied to the navy as well.

Enormous harm was done by the late Minister of Marine, Admiral von Trotha, an officer of the highest professional attainments, but an uncompromising reactionary in politics. There is no doubt that he attempted to use the fleet as an instrument for the furtherance of Monarchist aims. This was bitterly resented by the seamen, and when, at the time of the Kapp affair, he pledged the navy's allegiance to the usurping faction, there was a general mutiny at the naval ports. Von Trotha's conduct bears out the oft-repeated statement that politics was one of the root causes of the German Navy's collapse. Further confirmation has just been supplied by Grand Admiral von Tirpitz, whose dissertation on the state of Europe, published in *The Times* last week, reveals him in his true guise as a zealous, but woefully misinformed politician. Had von Tirpitz set an example to his subordinates by studying Mahan and Colomb, instead of saturating himself with the Pan-German doctrines preached by Treitschke and Schiemann, the German Navy might have proved less of a dismal fiasco in the late war. If von Tirpitz's appreciation of *Weltpolitik* gives the measure of his acumen in other matters, we need marvel no longer at the shipwreck of German naval policy.—*The Naval and Military Record*, August 11, 1920.

SHIPBUILDING IN GERMANY.—The extent to which the construction of new ships is being carried on in Germany at the present time is probably not known outside the initiated circles of that country. The returns concerning the situation of the world's shipbuilding industry at the end of June in the current year were accompanied by the statement that the figures for Germany were not yet available. It is known, however, on the one hand, that the shipyards have been occupied for many months past with the completion of ships already in hand at the date of the Armistice, the repair of other vessels, and the finishing of floating docks for surrender to the Allies under the Treaty of Peace. Two of the docks of large dimensions are said to have been sold by, or with the consent of, the Reparation Commission, and to have been delivered to Holland and Norway respectively in the past few weeks. But it is known that ships were in progress in the German yards during the same period for the account of the Reparation Commission, and also for delivery to neutral countries. Indeed, it is claimed

that although many contracts for neutral nations are still on hand, orders for neutral account similar to those which were extraordinarily remunerative a few months ago are no longer expected, as, owing to the inflated prices for iron and steel, the costs of construction have risen to the level of, even if they are not higher than, the prices prevailing in the world's markets. If the assertions respecting orders for work for other than Allied account are well founded they may possibly refer to small ships of 1000 gross tons and less, but if the reports be true that much larger vessels have been or are being completed, it is impossible to avoid the impression that the Reparation Commission is in no hurry to exact the delivery of the particular amount of tonnage set forth in the Treaty. The Treaty provides that within three months from its coming into operation the Reparation Commission shall notify to the German Government the amount of tonnage to be laid down in each of the two years next succeeding the three months in question. No doubt such a notification was given, but the exact tonnage concerned has not yet been stated. A similar notification is to be given two years after the Treaty came into operation with regard to the three following years, and the amount of the tonnage to be laid down is specified as not to exceed 200,000 tons gross per annum.

The opinion prevails in certain circles in Germany that the Allies will not incessantly demand the delivery of the ships provided for under the Treaty of Peace. This optimism is based, not upon any question of change of opinion on the part of the Allies, but solely upon the assumption that the reaction taking place in freights is causing, or has already caused a decline in the number of new orders received for ships both in Great Britain and the United States, and that with less work in prospect in the future Allied shipbuilders would not look on quietly while the German yards were busy on the production of ships for the Allies. We reproduce this view of the problem for what it is worth. At the same time there is no doubt that the German yards are constructing, and are being permitted to construct, ships other than those for the Allied account, consistently with the quantities of raw materials available. This view is supported by the fact that the shipowners and shipbuilders are demanding the delivery of twice as much shipbuilding material as they received in pre-war times, and are making representations to the Ministry for Economic Affairs, complaining that the steel makers are exporting three times the monthly tonnage of ships plates, etc., supplied to the national shipyards—a complaint which the iron and steel interests affirm is without foundation, 8000 tons monthly being delivered in each case. It is not easy to reconcile zeal of this character with work for Allied account and at prices per ton to be determined and accounted for by the Reparation Commission. It thus seems as if some relaxation of the conditions relating to the delivery of ships has already been made. As bearing on this matter, the following passage may be quoted from a German newspaper: "If we were entirely free in shipbuilding, and if we had sufficient constructional materials and a body of workmen again glad to work efficiently, it would probably be possible for our shipowners, with the large-hearted assistance of the Reich, within a few years to fill up in some measure their stock of ships by means of new construction in our own country." The total production of the shipyards in Germany, in 1913, amounted to 510,000 gross tons, including warships, and included 34,000 tons for foreign account. It is calculated that with the new shipyards built during the war or approaching completion, and the extensions now in progress, the productive capacity of the country has been advanced or will soon be increased to 1,000,000 tons per annum. But there is a vast difference between output capacity and actual output, and a long time will necessarily elapse before the production reaches the level of that which prevailed in 1913 unless a very substantial improvement takes place in the supplies of raw materials to the iron and steel works, and consequently of semi-finished and finished materials and of machinery for the shipyards. The country has adequate coal resources, but it is desired to keep deliveries for home consumption; the pro-

duction of pit coal was 10,000,000 tons greater in the first half of this year than in the corresponding half of 1919. In the case of iron ore there has been a considerable increase in the imports from Sweden this year. Iron ore resources have been obtained in Brazil; and German emissaries scoured Spain, South America and the Dutch Indies during the war in order to secure ore concessions, and have succeeded in some cases, while hopes are entertained of again receiving ore from South Russia at no distant date. Of course, most of these problems relate to possible future developments, thus showing the foresight exercised by the iron and steel interests during the years of hostilities.

For the present, German hopes are concentrated on the possibility of reconstructing the merchant fleets. Builders have been complaining that they are hampered not only by the scarcity of shipbuilding materials, but also by the high prices charged for them. They, however, now have the satisfaction of knowing that the price reduction of two months ago was followed by a further decrease last week, so that the costs of construction should further decline. The policy of steel makers taking up financial interests in shipyards, which was begun before and continued during the war, is now being extended so that the yards are gradually becoming assured of constant deliveries of plates, sections, etc. But the limits imposed by the iron ore problem upon the production of these materials will retard the revival of the shipbuilding industry on a large scale for some years.—*The Engineer*, Aug. 6, 1920.

GREAT BRITAIN

IRELAND IN WAR TIME.—In view of our leading article a few weeks ago on the strategical aspect of the Irish problem it is interesting to note that Mr. Lloyd George has just told a Labor delegation that the granting of complete independence to Ireland would not be compatible with the security of British communications. He referred to the very large number of ships sunk by German U-boats off the Irish coast, and developed the point, raised in our article, that if during the war the Irish coast had been in hostile possession we could scarcely have hoped to overcome the submarine menace. It is reassuring to find that the government is not unmindful of this highly-important aspect of the Irish question, to which far too little attention has hitherto been paid. Fairness compels us to add that service opinion is not unanimous as to the influence that Irish independence would have on a future war in which Great Britain was involved. We remember a prize essay published in *The United Service Magazine* some eight years ago on the subject of what changes would take place in the existing stretegical position of this country owing to a maritime war (1) if Ireland were neutral; (2) if that country were hostile. The writer denied that an enemy who proposed to invade England would gain any advantage by first landing troops and stores in Ireland. As regards the trade routes, he concluded that Irish hostility would not affect naval strategy, for Ireland had no navy. It would, however, facilitate the seizure and occupation of a suitable base. His summary of the whole matter was as follows: Ireland, possessing neither an army nor navy, could not enforce neutrality, and therefore her pretensions to neutrality would be wholly ineffectual. Ireland's hostility would react upon the military rather than the naval situation. It would not alter very much the distribution of the fleet, for that depends mainly on the whereabouts of the enemy's fleet, and an enemy would be unlikely to send his fleet into Irish waters which are in the area of Great Britain's maximum control where our fleet could wage war most successfully. This, of course, was written before the day of the long-distance submarine and its application to commerce-destroying work. In the essayist's opinion, Irish independence had another aspect in its relationship to war: "War is a reality, and its reality lies in this—that it requires a principle and practice of government entirely different from the piping times of peace. Ireland's

economic existence is based on Great Britain. Her commerce and her shores are protected by our fleet, but the pillars of her national life are lost to view in the froth and spume of Hibernian provincialism. Ireland can only approach others by sea, and her real independence can only rest on British supremacy at sea. Ireland, so far as the sea is concerned, must remain one with Great Britain."—*The Naval and Military Record*, August 4, 1920.

NAVAL RESEARCH AND EXPERIMENT.—In nearly every proposal that we have seen with regard to the broad principles which should govern British naval policy in the years ahead great emphasis is rightly laid on the necessity of devoting a generous percentage of available funds to reasearch and experimental work. The Admiralty have given a definite assurance that everything possible will be done in future to keep the navy abreast of scientific and technical progress. A Department of Scientific Research and Experiment has been created under the Controller of the Navy, and steps are being taken to extend the facilities enjoyed by the service for working out problems in connection with the development of every description of naval material. For instance, experimental establishments have been attached to the technical training schools at Portsmouth, and it is well known that they have already performed a great deal of useful work in improving mines, torpedoes, and electrical apparatus. Another branch which the war brought into existence is the Anti-Submarine School, an institution of capital importance which ought on no account to be handicapped by lack of funds. The Admiralty's general scheme for promoting research looks satisfactory enough on paper, but we know from experience that these excellent projects have a way of getting quietly shelved in the course of time unless the searchlight of publicity is trained upon them at regular intervals. Next to the welfare and contentment of the personnel, we consider an unremitting study and application of war experience to tactics and material to be the most important present-day duty of the naval administration.

It would be absurd to pretend that the weapons and material we possessed at the outbreak of war were as perfect as they might have been. The German torpedoes, mines, and projectiles were superior to ours, and it is no use denying that the efforts of our commanders at sea were often stultified by the indifferent material they had to work with. Apparently there had been too much theory and too little experiment. It seems almost incredible that the deficiencies of our armor-piercing shell—to mention one notorious example—were not discovered until the day of battle. The suggestion that the projectiles were the best that could be manufactured at that period is preposterous; moreover, it is disproved by the fact that as soon as the failure became known we at once set about producing shell of infinitely better quality, although the enemy never gave us an opportunity to test them upon his ships. In this case no doubt departmental conservatism was at the root of the trouble, but a contributory cause was the short-sighted policy that refused to spend money on practical trials. Before the war we often drew attention to Germany's lavish expenditure on the testing of her naval weapons. It was the invariable practice there to make exhaustive tests of every class of material before finally accepting it for naval purposes. No new gun was adopted until it had been tried under conditions resembling as nearly as possible those of actual war. New projectiles were fired against targets representing the most strongly armored ships of the day, and if they failed to do all that was expected of them an improved type was at once designed. In this way the Germans had evolved a shell that would carry its powerful bursting charge through the thickest armor, while we had no thoroughly reliable A. P. shell until the third year of the war. The same policy of striving for maximum efficiency, regardless of trouble and cost, was pursued in the development of gunnery, torpedoes, mines, and systems of armor protection. Of course, it was a costly business. Between

1908 and 1914 Germany is said to have spent four times as much money on this sort of thing as we did, but her method proved in the end to be the most economical.

In the light of present knowledge it can be asserted with confidence that had all our material been as technically efficient as Germany's was, the task of crushing her at sea would have been enormously simpler and cheaper. Experience that might have been purchased in pease time for a very modest sum had to be hurriedly acquired in war at a terrific cost. It is not enough that the navy has learned its lesson in this respect; public opinion also needs to be reminded that the mere voting of money for men and ships is not the whole of its duty to the service. It is for the Admiralty to insist on proper financial provision being made for the continuance, on a scale of reasonable dimensions, of the research and experimental work that was in full swing towards the end of the war. Unless this is done the priceless experience we gained from the war will be wasted. As the Admiralty have said, "To stop pure research work altogether at this moment would be a retrograde step, and might conceivably have a serious effect ultimately on development of types of ships and weapons, and on economy generally." Advantage might profitably be taken of the pause in new construction to press for an increase in next year's vote for "scientific research and experiment," which in the current estimates stands at about £285,000. This sum is so obviously inadequate as to suggest that the old penny wise pound foolish system is already in force once more.—*The Naval and Military Record*, August 18, 1920.

DEVELOPMENTS IN NAVAL DESIGN.—On the occasion of his recent visit to the industrial centers of Yorkshire, Admiral of the Fleet Lord Beatty made an important statement relative to naval policy. Speaking at Sheffield, he said that the history of the British Navy acquitted it of any taint of aggression, and was a sufficient guarantee that its powers would be exercised for the benefit of all those who used the seas for lawful purposes. Since the war, he proceeded, there had been no new construction; but ships did not last forever, and progress in science and in technique combined to shorten the "life" of a man-of-war. The Admiralty, however, took the view that we could afford to pause before resuming naval construction. The policy of the moment was to investigate the problems of war, and to assimilate and coordinate the lessons derived from experience, so that when the time came, as come it must, to turn those lessons to a useful purpose, they should be applied with wisdom and understanding. So far as facilities for experimental and research work were concerned, the navy was better equipped to-day than it had ever been before. He concluded by deprecating the wild and fantastic theories which had lately been propounded in certain quarters, "where surprise is felt that we are not to-day constructing big ships which would dive beneath the waves one minute and ascend into the clouds the next." The First Sea Lord's speech is a much needed reminder that our naval commitments did not terminate with the conclusion of peace. That we are able to postpone for a certain period the laying down of new warships is due, not to any fundamental change in the principles of national defence which hitherto have impelled us to maintain a supreme navy, but simply to the fact that our present margin of strength suffices to meet the requirements of the immediate future. Sooner or later, however, this margin will disappear—already it is shrinking visibly—and when that occurs it will be the duty of our naval authorities to submit a new shipbuilding program. Meanwhile the Admiralty, as the First Sea Lord assures us, is utilizing the pause to determine what modifications in ships, machinery and weapons may be indicated by war experience. It is quite clear that the present board is in no mind to dispense with the battleship altogether. Its views on the question were set forth in the First Lord's memorandum circulated on March 12. This document stated that the Naval Staff, having examined

the question with extreme care, profoundly dissented from the opinion that the battleship is dead and that submersible and air vessels are the types of the future. "In our opinion," it was added, "the capital ship remains the unit on which sea power is built up. So far from the late war having shown that the capital ship is doomed, it has, on the contrary, proved the necessity for that type."

We may, then, assume that capital ships will form part of the new naval program to be introduced when circumstances render it expedient, the more so because it is in this type that our lead is rapidly diminishing by reason of competition abroad; but no one outside the councils of the Admiralty is able to forecast the characteristics of our future ships. It is commonly supposed that H. M. S. *Hood* represents the last word in British naval design. This is an error, for the Assistant Chief of Naval Staff, Captain Sir A. Chatfield, has told us that if a new ship were to be laid down immediately it would not be a second *Hood*. He admitted that naval opinion no longer attached to high speed the importance that it did before the war, and that substantial protection was now considered an indispensable feature of every ship intended to lie in line. It would, however, be premature to conclude from this that the battleship of the future will be smaller and cheaper than the latest existing types. True, the demand for great speed has materially contributed to the enormous growth in dimensions, and when, as in the case of the *Hood*, that demand is coupled with a heavy armament and complete protection, it inevitably leads to huge displacements. But if the naval tactician is ready to forego high speed, it does not follow that he will consent to part with the extra percentage of displacement necessitated by installing high-powered machinery. On the contrary, he is more likely to resist a reduction in size on the ground that the weight saved on machinery can be profitably utilized by strengthening armament and protection. Nor would such an attitude on his part be unreasonable, for it is certain that the standard of offensive and defensive power, as represented by the *Hood*, will have to be raised if our future designs are to bear comparison with the best foreign ships. A "modified *Hood*," mounting the same armament as that ship and embodying the same system of protection, but with a speed of 25 knots instead of 31, might be built on a displacement of 32,000 tons, as against 41,200 tons; but if an extra pair of guns and a few extra inches of armor were postulated the figure would probably rise of 40,000 tons, if not more. As evidence that high speed is not necessarily the capital factor in determining size, we may instance the new American battleships. The *North Carolina* is not a particularly fast ship judged by modern ideas, for her machinery is estimated to develop 60,000 shaft horsepower for a speed of 23 knots; yet she displaces no less than 43,500 tons, or 2300 tons more than the *Hood*. In this case most of the weight has gone into artillery and armor. The *North Carolina* is to be armed with twelve 16-inch 50 caliber guns, and sixteen 6-inch quick-firers, which—counting the primary armament alone—will enable her to deliver a broadside of 25,200 lbs., as against the *Hood's* 15,360 lbs. Her belt armor is reported to have a maximum thickness of 16 inches, and all the main fighting positions to have equally substantial protection. It is obvious, therefore, that except in the matter of speed this American vessel will possess a marked tactical advantage over the *Hood*, and speed, as we have said, is an element to which British naval opinion no longer attaches cardinal value.—*The Engineer*, August 13, 1920.

ADMIRALTY CONCESSIONS TO THE LOWER DECK.—The decisions by the Admiralty on the requests put forward through the Welfare Committee in October, 1919, are promulgated in Fleet Orders. Altogether 307 requests,

great and small, were put forward, 80 of which were of a general character and the remainder appertaining to particular classes. Each request has been carefully considered by the Board, and over 100 have been granted in whole or in part. In certain instances decisions have yet to be announced, many questions to which they relate being under consideration by special committees.

The principal benefits granted as a result of the welfare system during the year are set forth as follows:

(a) Permanent institution of marriage allowance.

(b) Increase of provision and long leave allowance from 2s. 1d. to 3s. 6d. a day in view of the present high cost of living.

(c) Improvements to be made in men's accommodation both in ships and shore establishments.

(d) Change of uniform for petty officers over four years.

(e) Improved scales of pension for service for men invalided for war disability.

(f) Concession to old roll pensioners.

To a request that the mate scheme of advancement from the lower deck to commissioned rank should be open to all branches, with a few exceptions, the Admiralty reply that they are not prepared to extend the scheme to other than the seaman and engine-room branches, and the number of ratings advanced must depend on the requirements of the service. It is clear from the number of requests involving the principle of automatic promotion that there is a considerable body of feeling among the men in favor of it. The Board, however, are of opinion that automatic promotion is not in the interests of the Service.—*The United Service Gazette*, Aug. 12, 1920.

JAPAN

JAPANESE BUILDING PROGRAM.—Much interest has been aroused in this country over the Japanese naval building program which calls for the construction of eight superdreadnoughts and eight battle cruisers—the eight-eight program, as it is termed. Information at hand shows that the battle cruisers of the *Akagi* and the *Amagi* type, are to be smaller by more than 3000 tons than the American dreadnought battle cruiser Saratoga and her class.

The *Akagi* and the *Amagi* are in a class of four under construction, the others being the *Atago* and the *Atako*. Four similar vessels are projected. Figures obtainable show the following comparative measurements of the *Akagi* class with the *Saratoga* class:

Akagi class—full load displacement, 40,000 tons; speed, 30 knots per hour; main battery, eight 16-inch guns; shaft horsepower not definitely known. One report is that the shaft horsepower is 250,000, but this is not believed, as the larger vessels of the *Saratoga* class are to be faster than the *Akagi* class with much less horsepower than 250,000.

Saratoga class—full load displacement, 43,500 tons; speed, 23.25 knots per hour; main battery, eight 16-inch guns; shaft horsepower, 180,000.

The Japanese dreadnoughts *Negato* and *Mutsu* are compared with the ships of the American Colorado class in that they are of the same classification and almost of a size. The Japanese vessels will have a slight advantage over the Colorado class in displacement and more than two knots better speed. The comparison follows:

Colorado—Full load displacement, 33,590; speed, 21 knots main battery, eight 16-inch guns.

Negato and *Mutsu*—Full load displacement, 33,800; speed, 23.5; main battery, eight 16-inch guns.

The Japanese vessels are supposed to be four-turbine ships. The *Negato* was launched on Nov. 16, 1919. The *Mutsu* was launched on May 31, 1920. The material for two other vessels of this class is being assembled. Four others are scheduled for completion in 1929. Of the battle cruisers of the eight-eight program two are being built to be completed by 1923, two others have been authorized and four are projected. These last mentioned six should be completed by 1927.

A comparison of the United States and Japanese battle fleets in 1923 will show the following:

United States—Battleships, 17; 14-inch guns, 84; 16-inch guns, 104; displacement, 624,074 tons.

Battle cruisers, 6; 14-inch guns, 0; 16-inch guns, 48; displacement, 261,000 tons.

Total weight of broadside fire of American battle cruisers, 98,304 pounds.

Japan—Battleships, 8; 14-inch guns, 48; 16-inch guns, 32; displacement, 258,860 tons.

Battle cruisers, 6; 14-inch guns, 32; 16-inch guns, 16.

Total weight of broadside fire of Japanese battle cruisers, 76,704 pounds.

In the seventeen battleships of the American fleet, built and building, are six vessels of more than 40,000 tons displacement. All are included in the program to be completed by 1923. In addition to these the United States is building four battleships of more than 33,000 tons.

All the new super-dreadnoughts of more than 33,000 tons and more than 43,000 tons will carry batteries of 16-inch guns, the four ships of the *Colorado* class having eight each and the six ships of the *South Dakota* class having twelve each.

The *Saratoga* class of battle cruisers, which the Navy Department hopes to complete by 1923, comprises six vessels. The American Navy has no battle cruisers in commission.

Under the intensive Japanese building program, eight battleships and six battle cruisers are to be completed by 1923 and it is expected that the rest of the Japanese program for capital vessels—those capable of going into the first battle line—will be completed in 1927 with twelve battleships and twelve battle cruisers added to the fleet. In addition, the Japanese program calls for eight high speed cruisers of 6000 tons, twenty-four light cruisers of 5000 tons, thirty-two destroyers of 1300 tons, thirty-two destroyers of 850 tons, twenty-four submarines of 1300 tons, forty submarines of 800 tons, and twelve special duty ships of about 12,000 tons.—*New York Times*, Aug. 27, 1920.

JAPANESE LAUNCHINGS IN FIRST HALF-YEAR.—The number and tonnage of ships of over 1000 tons gross launched in Japan during the first six months of 1920 were as follows:

Month	Number of ships	Gross tonnage
January	6	25,605
February	7	41,415
March	13	58,330
April	12	56,725
May	10	51,850
June	8	32,770
Total	56	266,695

—*The Nautical Gazette*, Sept. 9, 1920.

UNITED STATES

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, AS REPORTED AUGUST 31, 1920

Type, number and name	Contractor	Per cent of completion			
		Sept. 1, 1920		Aug. 1, 1920	
		Total	On ship	Total	On ship
Battleships					
44 California	Mare Island Navy Yard	93.6	91.8	92.9	90.9
45 Colorado	New York S. B. Cpn.	57.6	51.4	55.1	46.3
46 Maryland	Newport News S. B. & D. D. Co.	79.4	77.9	77.7	73.9
47 Washington	New York S. B. Cpn.	50.2	39.8	48.9	37.8
48 West Virginia	Newport News S. B. & D. D. Co.	32.5	17.5	31.5	15.5
49 South Dakota	New York Navy Yard	14.5	6.7	13.3	5.5
50 Indiana	New York Navy Yard	11.5	3.7	10.9	3.1
51 Montana	Mare Island Navy Yard	11.2	4.	11.	3.4
52 North Carolina	Norfolk Navy Yard	14.7	8.6	14.1	7.9
53 Iowa	Newport News S. B. & D. D. Co.	6.5	4.1	4.5	3.5
54 Massachusetts	Beth. S. B. Cpn. (Fore River)	....	.....	....	....
Battle Cruisers					
1 Lexington	Beth. S. B. Cpn. (Fore River)	1.3	.3	.7	....
*2 Constellation	Newport News S. B. & D. D. Co.	.9	.1	.7	....
3 Saratoga	New York S. B. Cpn.	3.1	.4	.7	.2
4 Ranger	Newport News S. B. & D. D. Co.	.7	.....	.7	....
5 Constitution	Phila. Navy Yard	1.	.3	1.	.3
6 United States	Phila. Navy Yard	1.	.3	1.	.3
Scout Cruisers					
4	Todd D. D. & Const. Cpn.	64.9	54.	58.5	41.2
5	Todd D. D. & Const. Cpn.	56.1	44.4	51.3	36.6
6	Todd D. D. & Const. Cpn.	37.4	14.8	34.4	10.7
7	Beth. S. B. Cpn. (Fore River)	13.3	6.6	8.7	4.6
8	Beth. S. B. Cpn. (Fore River)	12.6	5.9	8.7	4.6
9	Wm. Cramp & Sons Co.	52.	.....	48.	....
10	Wm. Cramp & Sons Co.	51.	.....	47.	....
11	Wm. Cramp & Sons Co.	27.	.....	20.	....
12	Wm. Cramp & Sons Co.	28.	.....	20.	....
13	Wm. Cramp & Sons Co.	21.	.....	20.	....
Miscellaneous					
Fuel Ship No. 17, Neches	Boston Navy Yard	95.	94.3	88 9	87.8
Fuel Ship No. 18, Pecos	Boston Navy Yard	36.	29.	32.3	24.5
Gunboat No. 22	Charleston Navy Yard	58.4	46.1	54.1	41.1
Hospital Ship No. 1, Relief	Phila. Navy Yard	96.5	95.5	94.	92.5
Amm. Ship No. 1, Pyro	Puget Sound Navy Yard	Comm.	8/10/20	99.9	99.9
Amm. Ship No. 2, Nitro	Puget Sound Navy Yard	98.9	96.6	98.5	95.5
Rep. Ship No. 1, Medusa	Puget Sound Navy Yard	53.5	43.5	53.	43.
Destroyer Tender No. 3, Dobbin	Phila. Navy Yard	29.7	29.	27.2	26.
Dest. Tender No. 4, Whitney	Boston Navy Yard	1.5	1.	.5	.5
Sub. Tender No. 3, Holland	Puget Sound Navy Yard	5.5	.....	5.	....
Oil Tankers					
1660 Tippe Canoe	Newport News S. B. & D. D. Co.	Del'd	8/4/20	99.	.....
1661 Trinity	Newport News S. B. & D. D. Co.	99.	.....	95.	.....

Authorized but not under construction or contract:
(1) Transport No. 2.

NOTE: Airplane Carrier U. S. S. Wright will probably be delivered to the contractors for conversion October 15, 1920.

* Keel laid August 18, 1920.

In addition to the above there were under various stages of construction 60 destroyers, 49 submarines and 3 sea going tugs.

In addition to the ships noted in the tables, there were commissioned or delivered to the Navy Department during August 6 destroyers and one sea going tug.

There are authorized but not under construction or contract 12 destroyers and 7 submarines.

AMERICA AND POLAND.—It is one of the tragedies of the world we live in to-day that it produces no statesman of vision. The course events in Russia were taking was plain when the war ended. But the peace was made in a cloud of words and phrases as if the catastrophe in the East had no meaning for the West. The United States, being furthest away from it, has placed herself in a more difficult position than any of the other Allies for dealing with it. But there is a very real fear in American official circles of Bolshevism spreading across the Atlantic. That is why Mr. Colby, the Secretary for Foreign Affairs, whose views are also those of the President, has sent such a strongly worded Note to the Italian Government, who asked for the Washington standpoint in the matter. In it Poland's independence is upheld and the Soviet Government denounced as a menace to all moral, political and social principles upon which our civilization is based. Since the Senate has hung up the Peace Treaty the United States can give little practical effect to her policy. She cannot send naval or military aid, munitions, or arrange for a financial loan. But the Note definitely places her on the side of France as opposed to entering into any relations with the Terrorists, and gives Poland moral support at a very critical moment. It clears the air considerably, too, that the Government of a Great Power, and one whose democratic basis is so solid, should speak out plainly on the true nature and aims of Bolshevism. As in the Great War, so in the struggle which is just beginning, America, if slow in taking an active part, is quick to show where her sympathy lies.—*The Army and Navy Gazette*, Aug. 21, 1920.

IS NAVAL DESIGN IN THE FLUX?—Are naval design, construction, strategy and all the rest of it in a state of flux? When Beatty led the German fleet into contact with the British, Jellicoe, with twenty-five battleships, had the speed and power to close in and absolutely annihilate the Germans. Why did he not do so? Because of his very proper fear of the torpedo. He escaped torpedo damage by keeping the German destroyers at such a distance that their torpedoes were discharged haphazardly, lost their speed before they reached the British line, and were easily avoided by maneuvering.

Have you ever considered that the gas engine is liable to upset many of the theories and practices of naval construction and warfare? It is a thought well worth consideration, and we invite attention to it just now.

Is it not rather strange that the British should have scrapped half their battleship fleet and stopped all battleship construction? And that they should so complacently sit down and watch another navy spending seven hundred and fifty million dollars on eighteen battleships and battle-cruisers which, theoretically, when completed, will wrest from her that protective supremacy at sea which she has always believed, and still believes, to be necessary to the security of her far-flung empire? Why this complacency? If you asked Admiral Benson, he would probably answer: "They are hard up. It is necessity." But can we be so sure of this? Is it not possible that their vast war experience showed the British that the terrific punishing-power of the torpedo, due to new methods of bringing it within point-blank range of the enemy, demands a radical revision of some of our fundamental war concepts?

We believe that in future war the torpedo will at last come into its own, and it will be the internal combustion engine that will work the change. It gave us the motor car and the airplane, and now it is perhaps destined to

dethrone the battleship and battle-cruiser as the supreme elements of naval strength. But how? Well, the British have several large and fast torpedo-plane carriers. Let us forecast a duel between a twelve-gun, 23-knot *Massachusetts*, and a 32-knot torpedo-plane carrier, with twice that number of planes aboard. Steaming outside of 16-inch gun range, the carrier would send in her planes which, swooping down from great height at 150 miles an hour, would drop their torpedoes within close range and return for more. But the bulge will save the ship? No; for the torpedoes will be set to pass underneath the ship and they will be fired magnetically by the action of the steel mass of the ship itself. And you could not put side and bottom bulges, both, upon a ship—she would be all bulge and but little ship.

Again, the internal combustion engine has opened up another form of attack in the shape of the so-called one-man torpedo boat—a type which is coming along very fast. It begins to look as though the gas-driven, high speed, motor boat, carrying its torpedo discharge below water, would fulfil the functions in which the torpedo boat failed utterly and the destroyer partially. It has the torpedo efficiency of the destroyer without its size and visibility. To hit, the torpedo must be fired at close range—the Germans found that out at Jutland. The torpedo motor boat is so small a mark that it can dash in at thirty knots to within point-blank range without the anti-torpedo gunner being able to draw a bead upon it, so rapid is the change of range; and twenty sea-going motor boats can be sent in for the cost of one destroyer.

Seaworthiness? Well, they are growing in size, and the latest type would have no difficulty in keeping station as part of a fleet organization.

There are evidences, clear to the close student of naval development, that naval theory, construction, strategy and tactics are very much in the flux just now, or soon will be.—*The Scientific American*, Aug. 14, 1920.

THE DESIGN OF WAR VESSELS AS AFFECTED BY THE WORLD WAR. (Rear Admiral David Watson Taylor, Chief Constructor U. S. N.).—The Battle of Trafalgar was fought October 21, 1805, or early in the nineteenth century. In the early part of the present century the tactics employed in that battle were still being discussed, but although Nelson's Flagship, the *Victory*, is preserved by England at Portsmouth, it is of no interest from a material point of view to designers of war vessels of the present day. Similarly, with the rapid engineering development of naval material which has been going on for more than 50 years and bids fair to continue, the material lessons from the World War must be gathered within a comparatively short time. Even so, to answer fully the question, "What has been the effect of the World War on warship design?" is not as yet possible. For years it will be necessary to collate and study an enormous mass of experience, some written, some oral, some originating from the responsible controlling bodies of the great navies, and much from individuals, including not only those of great eminence, but many whose names will never emerge from comparative obscurity, though their experience in the aggregate may in the long run exercise a dominating influence.

As a practical proposition the full effect of war experience will be demonstrated in concrete form only after service opinion has been crystallized and become definite in direction as a result of study and discussion by a large number of officers. Certainly that will be the case in the American Navy where the organization is such that service opinion necessarily controls policy in the development of naval types. The service is a customer of the naval designer, and although the latter may influence and at times interpret and lead service opinion, the customer will have what he demands. What I say to-day must therefore be taken more in the light of a discussion of this intensely interesting subject, than as a hard-and-fast laying down of principles or expressions of final opinion.

Let me call attention at once to the fact that, after all, there has been nothing startling or revolutionary brought about by the experience of

51 months of war. There has mainly resulted an intensive development of each of the accepted types which existed at the outbreak of the war and which were the results of many years of study, experiment, and practice in all of the great navies of the world. It is true that some new types have appeared, but with one exception, namely, aircraft carriers, they have been of minor importance when measured by the cost and time required for production.

When we consider types and not details, we must not look only to the few naval battles of the World War which can justly be classed as major actions for the influences affecting our naval construction of the future. It is necessary to consider the particular trend of naval events, the accumulated experience, and the principal phases of naval activity during the more than four years of hostilities.

The first of these must naturally be the causes which gave not only the initial but the continuing command of the sea to the Allies. We know that at the outbreak of the war all German mercantile vessels quickly disappeared from the high seas, being either held in their own ports or promptly interned in neutral ports. On the other hand, Allied commerce proceeded on its way. It was not the great British Battle Fleet which the German merchantmen feared, for they knew that this fleet would be concentrated at one point within easy striking distance of the German coasts and therefore it could be easily avoided. What they feared were the Allied cruisers, auxiliaries, destroyers and light vessels of every class. Just as the few German cruisers which were at large were captured or sunk within a few months, so could this cloud of Allied light craft have been swept from the seas had the German heavy fighting forces been able operate without first giving battle to the superior British Battle Fleet. They were unable to do this at any time during the war. As a result every military effort of the Central Powers afloat and ashore was made more difficult because of the slow but sure throttling of their economic and industrial life. Without the British Battle Fleet the blockade of Germany would have been ineffective. This factor had such a determining influence, both on the duration and final outcome of the war, that the types of vessel which make up the main fighting fleets are more firmly established than ever as the essential ones contributing to naval power. If these great battleships and battle cruisers disappear, either in the near or the distant future, it will be as a result of engineering progress and the invention and perfection of new weapons and not as a result of the World War.

Battleships and battle cruisers were in actual conflict with vessels of the same type and power on only two occasions: at the Dogger Bank on January 24, 1915, and at Jutland on May 31, 1916. These actions, however, do not by any means represent the sum total of their activity. When the location and activity of the German Cruiser Squadron in the Pacific was disclosed by the tragedy off Coronel, two battle cruisers at once sailed to search out and destroy this troublesome squadron. Perhaps they were lucky in coming into contact with the enemy immediately, but the celerity and success with which they accomplished their mission at the Falkland Islands gave a great impetus to the favor in which this type was held by naval men. The immediate effect of this sentiment was seen in the British battle cruisers *Repulse* and *Renown*, which represent the extreme of the type; that is, armor and gunpower were sacrificed to speed to an even greater extent than in the original battle cruiser. These were quickly followed by an even greater extreme, the *Courageous*, *Furious* and *Glorious*, which can be denominated either small light battle cruisers or enormously large light cruisers, as they have the largest guns characteristic of the former and the total absence of armor protection characteristic of the latter, while possessing the high speed common to both. The battle off Dogger Bank served only to confirm the conclusions on which these two classes of ships had been laid down. In this engagement, the rival battle cruisers met for the first time, with the result that those on both sides demonstrated their

ability to stand heavy punishment without succumbing to fatal damage. Even the older German cruiser *Blucher,* which was inferior in gunpower, protection and speed to all of the others, succumbed only after surviving for a considerable period of extremely heavy punishment. If there had been no further war experience with the battle cruiser type it is likely that the idea that protection is not important for them would have prevailed, and the combination of extreme speed, guns of the largest size, and the minimum of protection might have been in favor for some years. But the Battle of Jutland gave a rude shock to opinions based on earlier actions.

The Battle of Jutland is easily the foremost single event of modern naval history. The controversial phases of the tactics employed in this battle are only of interest to the naval designer in so far as the material in the two fleets influenced the judgment and decisions of the high command on each side, and to the extent that new instruments of naval warfare, not then available but developed since, would have exercised a determining influence in the tactics employed; in the latter class comes the use of aircraft, and I will have occasion later in this paper to refer to the use and influence of aircraft in naval operations from the designer's point of view. By far the most important aspect of this engagement to the designer is the manner in which the various types of vessels engaged fulfilled the functions for which they were originally designed. In regard to type, the first outstanding fact is that battle cruisers must inevitably play an important rôle in major fleet actions. Each side in turn, first the Germans and then the British, used their battle cruisers to lead the whole or a portion of the enemy's fleet to contact with the main body of their own fleet. In fact, with the single exception of the *Warspite,* it was the battle cruisers on both sides that stood the brunt of the action and received the lion's share of punishment from the enemy. If the battle had been fought to a finish between the battleships, there might have been a different story to tell. The losses and heavy damages sustained by the vessels of battle cruiser type bear out to some extent the pre-war contentions of those who maintained that it was not fit to take its place in the line of battle. On the other hand, excepting their greater vulnerability, it cannot be denied that they acquitted themselves with credit even when pitted against the more heavily armed and armored battleship. Furthermore, not only was the value of their great speed demonstrated, but also the value of one side holding the speed gauge over the other was shown, for, it was due to the possession of higher speed by the British that the German Fleet, at the end of the second phase of the battle, found itself in a position which was so bad tactically that the German Chief-of-Staff is quoted as saying that if any admiral had involved himself in such a position in peace time maneuvers he would never again have obtained a command afloat. Another result from this action of general influence on type is found in connection with the use of older battleships, generally referred to as of the "pre-dreadnought" era. The German Fleet included one squadron of vessels of this type, and this squadron not only failed to be of any essential assistance to them but proved actually to be a handicap on their freedom of maneuver. The force of this lesson was shown by the fact that subsequent to the battle most of the German battleships of this type were retired from active commission. The material weakness of this type of older ships, when opposed to the most modern weapons, was shown in the case of the *Pommern,* which blew up and sunk immediately as a result of a single torpedo. The ineffectiveness of these older ships, as shown by many incidents of war, will be referred to later.

The ability of the large, modern, heavily-armored ships not only to survive, but to continue in action after the most severe punishment, was perhaps best shown by the British battleship *Warspite,* which, due to an unfortunate accident to the steering gear, sheered out of the battle line and made two complete circles within short range of the German Fleet. This vessel was hit by major caliber shell between 20 and 25 times. The net

result of this tremendous hammering was that one out of eight 15-inch guns was put out of action; there was no damage of any kind to her main machinery plant; the upper works and unprotected portions of the ship were riddled; communications were interrupted to a considerable extent; and some compartments at and below the waterline were flooded by water which came in from above, but none of the main compartments were affected to such an extent that the entering water could not be handled by the pumping arrangements provided. In short, although the ship had lost a certain amount of her margin of safety, due to decreased buoyancy and stability, and her speed had suffered on account of increased resistance due to her greater draft, she was entirely capable of resuming action after adjustments to her steering gear.

The *Marlborough* was another example of a battleship continuing in action after receiving what we were inclined formerly to consider would be a disabling attack. This vessel, although of the "dreadnaught" era, has not what is now considered a highly efficient form of protection against torpedo attack, yet, after being struck by a torpedo, resulting in the flooding of a number of compartments, which produced a list of about 7 degrees, the vessel continued in action at a speed of 17 knots.

Similarly, the German battleship *Ostfriesland* (of the "dreadnaught" era) was struck by a torpedo which produced some flooding, but the vessel was otherwise unaffected and continued on with the German Fleet.

No other British battleships received any considerable amount of punishment, but three of the modern German ships of this class received, respectively, 7, 7 and 13 hits from major caliber guns, but none of them were disabled or even damaged to an extent sufficient to prevent them continuing in action. The *Markgraf*, which was struck 13 times, is a particularly illuminating example of the amount of punishment which a modern heavily armored ship can stand. The only damage affecting the efficiency of the ship was the cutting of the communications from the masthead fire control positions, and this only resulted in shifting the control to the lower armored station provided for this purpose. The casualties on this ship were likewise remarkably low, as there were only 8 dead and 9 wounded, or only a little more than one casualty for each major caliber hit.

One particular class of hit of special interest to American designers is that in which turrets or their barbettes have been hit. Taking the case of four British and four German vessels which suffered heavy damage, it is found that out of a total of about 116 hits, 19, or 16.5 per cent, were on turrets or barbettes, of which 16 were struck. Of this number, four were completely put out of action and one gun in each of four others was disabled, while the remaining eight escaped without serious damage. In other words, out of 66 big guns carried by these ships, the emplacements of 32 were struck, but only 12 were sufficiently damaged to prevent their further use. This comparatively low proportion of casualty in the major offensive armament, together with the demonstration of the ability of the mechanism of a turret to continue to function even after the turret has had a direct hit, appears to dispose of the argument of "too many eggs in one basket" so frequently advanced against the American three-gun turret.

Turning to the damage sustained by the battle cruisers, one's attention is naturally taken first by the tragic loss of the three great British vessels of this type. Although in one case the Germans claimed a torpedo hit on one of them, it is generally accepted that the loss of all three was directly attributable to gunfire, but the immediate cause of the loss in each case is still, and always will be, shrouded in mystery. It is, of course, known that each one sank in an appallingly short interval of time and that in each case at least a portion of the magazines blew up. The mystery lies in the immediate cause of the magazine explosion. Many different explanations have been advanced, but all of these affect details rather than the general characteristics of type. There seems little doubt that one of two things happened: German shell either entered the magazine through penetration of

the protective deck, or, having pierced turret or barbette and exploded, flame was communicated to the magazine along the path followed by the ammunition from magazine to gun. From the fact that in the case of British ships that survived, there was only one case of penetration below the protective deck at any part (no harm resulted from this), it would seem to be highly improbable that the three battle cruisers were all sunk by protective deck penetrations directly over the magazines, and not very probable that any one of them was so sunk. We must not permit our judgment to be swayed too largely by this particularly spectacular phase of the battle. Just as in the case of the battleships previously referred to, the remaining battle cruisers on both sides demonstrated ability of modern ships of large size to withstand heavy punishment without losing their fighting efficiency. The battle cruiser type is essentially and unavoidably less thoroughly protected than the battleship type. This greater vulnerability must result in greater loss of the battle cruiser type, other things being equal; but in the Jutland fight the battle cruisers were engaged much longer and much more severely than the battleships, so that a greater percentage of loss of this type should have resulted even had their protection been equal to that of the battleships. A notable fact in regard to the modern ships, both battleships and battle cruisers, on both sides, is that not a single one experienced a disabling casualty to its machinery, either as a result of damage from enemy fire or as a result of engineering breakdown. In the case of one British ship and one German ship, fires were drawn from under the boilers in one fireroom, due in each case to leakage from adjacent compartments, but in each case this leakage was controlled by the pumping plant provided for the purpose. Leaving out the three lost battle cruisers, for which no data is available, the dozen large ships in the two fleets which bore the brunt of the punishment were hit a total of about 150 times by large caliber shell, or an average of more than 12 times each. Only one of these dozen ships, namely, the German battle cruiser *Luetzow*, sunk as the result of the damage received. Even this vessel sank only after six hours. She had received 17 large caliber hits and one torpedo. She continued to try to make the best of her way to port, but the struggle was given up about one o'clock in the morning; her crew was taken off by destroyers and she was finally sunk by a friendly torpedo.

The results of the battle, as a test of the defensive qualities of capital ships, show that in the entire action only four modern armored ships, all of them of the battle cruiser type, were lost as a result of the action. This was out of a total of 14 engaged and at least seven out of the remaining 10 survived heavier punishment than most designers in pre-war days would have considered possible.

Before the war there were two distinct schools of naval thought in regard to the main armament for the largest fighting ships. This difference of opinion existed internally in probably every navy, but internationally the American and British navies represented the "Big Gun" advocates, as is shown by the fact that in the former we find successive increases from 12-inch to 14-inch to 16-inch, and in the latter from 12-inch to 13½-inch to 15-inch. On the other hand, the Germans adhered for a number of years to the 11-inch gun and increased their caliber to 12-inch with apparent reluctance, and a larger caliber did not appear until close to the end of the war. There were undoubtedly excellent theoretical arguments on both sides of this contention. Even now the argument cannot be definitely settled in terms of absolute material results, for too many other factors, which cannot be eliminated, enter into the problem. A convincing answer, however, appears to be provided in the very decided trend of German Naval opinion since the Battle of Jutland. Practically every report from German sources and every German publication bearing on the Battle of Jutland lays stress on the superiority in range and accuracy of the British 15-inch guns. Even if no definite material advantage for the larger caliber gun could be established, there appears to remain a marked moral superiority on the side

possessing the biggest guns. This, of course, only confirms the previous views and policies followed in our service.

Summing up, therefore, we find that four outstanding facts of interest to the designer appear to emerge from the smoke and flames of the battle:

First. The value of armor protection.

Second. As a corollary to this, the necessity for the maximum number of major caliber guns; for, if the modern ship can withstand great punishment, we must, for purposes of offence, provide a sufficient number of guns to inflict a degree of punishment which will be fatal.

Third. The tactical value of speed.

Fourth. The futility of subjecting older ships to the attack of modern weapons.

In other words, the value of each one of the three major elements entering into capital ship design was demonstrated and it cannot be said that any single one has emerged with an importance transcending that of the others. If, however, one must choose among them, the consensus of opinion will probably attach more importance to protection than before the battle. This arises largely from two causes:

1st. The deep impression on the human mind by such an outstanding tragedy as the almost instantaneous loss of the three great British battle cruisers.

2d. The impression that German ships, generally speaking, stood punishment better than the English. Admiral von Tirpitz has been reported to have laid down as the fundamental principle of German design: That vessels before everything else must float; that they must not sink, and if possible, not even list, and that all else is of secondary importance.

This emphasis on the feature of protection is shown already by the intensified and successful efforts of both the British and the American navies to perfect an efficient form of torpedo protection. In this connection, I think I can safely say that both services have solved this problem so far as the torpedo has been developed to date. It is also interesting to know that during the war the two services frankly and fully compared their solutions of this problem, and that although the solutions differ radically in details, they do not differ much in underlying ideas and both are believed to be successful in result. This emphasis of the protective feature is further shown by the fact that our battle cruisers, whose construction was delayed, due to the necessity for our concentrating on the construction of torpedo craft and merchant vessels during the war, have been re-designed and given much heavier and more complete protection than was originally contemplated, accepting at the same time the slight decrease in speed necessitated thereby. We find precisely the same influence in the case of the latest British battle cruiser, the *Hood*, which was laid down shortly after the battle of Jutland and in which we find more than a 50 per cent increase in size as compared to the *Renown*, which I have previously referred to, an increase of protection almost to a battleship standard and a decrease in speed.

Turning to the lighter craft used in the Battle of Jutland, it will be found that at several critical times during the engagement both sides used their light cruisers and destroyers to obtain a tactical advantage. Each side likewise used craft of this character to repel the attacks of similar vessels of the enemy. Although the material effect was small, there being probably not more than six torpedo hits on the large vessels of both sides, the necessity for their use is clearly demonstrated not only by their success in obtaining certain tactical advantages, for which they were used, but also in the demonstation that if either fleet had been without these light craft, the torpedo casualties inflicted on the big ships by the light craft of the side possessing them would have been enormously greater. The losses of light

cruisers and destroyers on both sides were heavy in actual number, but not in proportion to the total number engaged, as will be seen from the following table:

	Light Cruisers		Destroyers	
	No. lost	No. engaged	No. lost	No. engaged
British	0	26	8	78
German	4	11	5	77
Total	4	37	13	155

Submarines played no direct part in this battle, and it is reliably established that neither fleet was accompanied by submarines, nor were any submarines even within striking distance of the scene of action.

Similarly, aircraft played no part in the action, although it is understood that it was a part of the German plan to utilize Zeppelins for scouting purposes in connection with the sortie of the Fleet and that this was only prevented by unfavorable meteorlogical conditions on the 31st of May. On the following morning, however, German aircraft were out over the North Sea and were undoubtedly of some small assistance to the German Fleet in insuring their safe withdrawal to their harbors.

Passing once more to the general phases of the war, we come at once the outstanding feature of the war at sea, the submarine campaign and the methods adopted to combat it. Now that the veil of secrecy has been lifted, we all know how close the German submarine campaign came to being an outstanding factor in the final result. Without entering into the legality and ethics of the German use of the submarine against merchant shipping, which all thoughtful and enlightened men join in condemning, we cannot escape the fact that we must in the future be prepared to find the submarine playing an important part in attacking and throttling enemy commerce. even on their own coasts. This is indicated by the result of the discussion at the Peace Conference when the world at large was so incensed by the barbarous methods used in the German submarine campaign that proposals were seriously put forward to abolish the submarine entirely by international agreement. This proposal, however, was wisely not adopted for, so long as the possibility of war remains, progress of science and engineering and their application to the art of war cannot successfully be throttled unless there is complete unanimity of sentiment throughout the civilized world. The use of submarines during the war has led to placing very great emphasis on the value of radius of action of these vessels, and with radius of action there must go hand in hand improvements in the living conditions on board, so that the physical endurance of the personnel may be sufficiently conserved to permit it to make full use of the material capabilities of the vessel. Both of these elements, even without the usual and concurrent demands for higher speed and greater offensive power, inevitably lead to increased size, except for a limited class of small boats, which, due to a particular strategic situation, such as that occupied by the Germans on the Belgian Coast, makes it possible to use with good results a large number of submarines of small size and limited speed and cruising radius. The technic of mine-laying has, during the war, so kept pace with the strategical and tactical demands for the use of this weapon, that the demonstrated practicability of laying them on the enemy's coast by means of submarines must in the future be taken into account, but this does not affect the general characteristics of the type, as the mine-laying feature can easily be substituted in whole or in part for the torpedo armament. Although the submarine was throughout the war something of a disappointment in the actual results which it obtained in inflicting loss or damage on the fighting ships of the enemy, its indirect effect on the freedom of the action of the main fighting fleets was so considerable that the problem of the development of the so-called fleet submarine is still with us and must be solved largely from theoretical and

engineering considerations, rather than from direct experience in action. Another use of the submarine, not largely foreseen, which developed considerable importance during the war, is that of scouting. It has been conclusively demonstrated that these underwater craft form one of the most valuable assets to a navy in obtaining and transmitting information in regard to the movements of the enemy's forces.

War experience developed and emphasized certain facts regarding submarines as a type which are very important from the point of view of a designer, and even more important from the point of view of those who have to determine the constitution of a navy. The submarine is essentially an instrument of stealth. Once detected, it must take refuge in the depths where, for any design not yet known, its offensive powers become nil, and to the depth charge or explosive bomb developed during the war it is exceedingly vulnerable. In other words, once detected and accurately located, a submarine is at the mercy of a surface vessel. While detection devices, in spite of the enormous effort expended upon them during the war, did not reach perfection, they made much progress and will undoubtedly be steadily improved as time goes on. If we had to-day an accurate device which would locate a submerged submarine with reasonable approximation several miles off, and with accuracy when one or two hundred feet directly under the surface vessel, the submarine would be already obsolete as a weapon of war. While we may never reach this ideal, and while the submarine may be given offensive features to enable it to deal in some fashion with the surface vessel from beneath the surface, the submarine is essentially a vulnerable, and, if I may so express it, a precarious type; is necessary to-day and probably will be for many years to come, but could not be relied upon as the main feature of a navy. We read at times of proposed submersible battleships and other such imaginations, but the experience of the war does not seem to indicate this as a probable future development even if mechanically possible.

On this same subject Sir Eustace d'Eyncourt, the Director of Naval Construction for the British Admiralty, very recently stated his views in the course of a paper presented before the British Institution of Naval Architects. He said:

"A good deal has been written and talked of lately about the surface capital ship being dead and the necessity for submersibles. But with our present knowledge it would be quite impossible to design a submersible ship which on the same displacement and cost had anything like the fighting qualities on the surface, which are possessed by the *Hood* (the latest British battle cruiser). Every ship is a compromise, and if in addition to the ordinary qualities of a battleship, she is required to submerge, or even partially submerge, a very considerable percentage of weight has to be added to give her this additional capability of submergence. She becomes still more of a compromise, and the added weight must detract from the fighting qualities of the ship when on the surface, so that whatever is done, other things being equal, the submersible ship must be inferior to a surface ship in an ordinary action. There are many difficulties of details in the design of a submersible battleship which would take too long to go into fully now, and although there is no doubt that submarines are capable of great development, a little thought will make it clear to anybody that if naval warfare is to continue, the surface ship of the line must still hold the field as the principal fighting unit of any great navy."

Considering types of war vessels existing at the commencement of the war, the position of the destroyer has been enhanced perhaps more than that of any other, and this has been brought about by our experience in its use against the submarine. As mentioned above, in discussing the results of the Battle of Jutland, the destroyer has established its indispensability for use with the fleet, both to attack the enemy and to protect its own capital ships. This use, however, was foreseen and provided for to at least a limited extent in all of the principal navies of the world before the war. It was not, however, foreseen that this type of vessel would be required in undreamed-of

numbers to protect the sea lines of communication from the lurking underwater enemy. During the first three years of the war, it had already been found that the destroyer was the most efficient type of vessel for hunting down and destroying submarines, and for convoying or protecting a particularly valuable transport or cargo ship. In the spring of 1917, however, the losses of merchant vessels had reached such an alarming rate that the responsible authorities recognized that a new and radical method of protection must be adopted. It was then that the convoy system was put into effect, and soon proved its efficiency to a degree which could hardly have been foretold. It became then imperative that convoy should be provided as nearly as possible for every ship approaching England and France. The only available type of vessel which could perform this very arduous service, requiring many days continuously at sea in all kinds of weather, frequently at very high speed in order to accompany high-speed transports, was the destroyer. This demand placed a tremendous strain on the resources of the Allies in this type of vessel, and it is now a historic fact that the United States Fleet was stripped of its destroyers which were sent to the war zone to perform this service, and that British destroyers were detached from the combined British and American battle fleets, upon which we depended to maintain our command of the seas, until that fleet was actually seriously inferior to the German fleet in destroyer strength. From our entrance into the war the United States Navy concentrated upon destroyer building, its destroyer construction undertaken during the war being on a scale never before considered possible. It is a matter of congratulation that this has resulted in our now possessing a fleet built or to be completed this year, of more than 300 modern destroyers of the most efficient type. In regard to the effect of the war on the characteristics of destroyers, the principal demand has been in the same direction as in the case of submarines, namely, for greater cruising radius and increased shelter and comfort for the personnel. Whereas, during the greater portion of the time of actual hostilities, convoy was provided for transports and cargo vessels only in the so-called submarine zone, extending 300 to 400 miles off the European coast, it had become evident before the Armistice that as soon as we had sufficient destroyers for the purpose, escort would have to be provided, at least for the most important groups of vessels, entirely across the Atlantic. This was brought about by the ever-increasing tendency of the German submarines to operate farther afield and by the approach to completion of a very large type of cruiser submarine, which it had been known for some time was under construction in Germany in considerable numbers. The later United States destroyers would have been prepared to cope with such submarines, as the size of their guns had been increased from 4 inches to 5 inches. To obtain these increased qualities without considerable increasing the size of the boats, which was of course undesirable under the emergency demand for quantity production, meant the acceptance of a small decrease in speed. This we could accept with equanimity as our destroyers were already somewhat superior in speed to the latest types of corresponding size abroad.

The necessities of the anti-submarine campaign brought about new uses for several existing type of vessels, and the development of several new types. It had always been contemplated that fishing trawlers, drifters and other small vessels of similar type could be used in time of war as mine sweepers and tenders. With the development of the depth charge, a bomb containing about 300 pounds of high explosive with a detonating mechanism, which functioned only when it had sunk to a certain predetermined depth below the surface of the water, it became evident that any small type of vessel possessing the necessary seagoing qualities could be usefully employed against the submarine. As a consequence, this became the principal use to which these small fishing boats were put during the last year and a half of the war. They could not, of course, perform the high seas functions of the destroyer, but they proved most efficient for hunting operations

and for coastal convoy purposes. The esteem in which they were held is shown by the fact that in the summer of 1917 the British Navy put in hand a construction program of more than 500 of these little craft. The limitations on the use of the fishing boats and the limitations on the production of the destroyer, due to its large size and cost, resulted in the development of intermediate types which would give good seagoing qualities combined with a speed comparable to the surface speed of the submarines themselves, and at the same time sufficiently small and simple in construction to permit of their production in large numbers. The British patrol boats and the United States eagle boats are the principal examples of this type. The latter is really a small destroyer of 200 feet in length and 600 tons' displacement, having a good cruising radius and a speed of 18 knots and carrying an armament of two 4-inch guns with unusually good command and a large number of depth charges, together with the various devices for dropping or throwing these bombs. The British also developed and turned out a considerable number of a somewhat larger type, which were known as "Sloops," which were given a slower speed but a larger cruising radius, together with a more robust type of construction and special features to insure their buoyancy in case of damage by torpedo. All during the war, as previously referred to, the best scientific talent, both in this country and abroad, was making every endeavor to perfect devices which would permit a vessel on the surface to hear a submarine moving below the surface. Various types of these so-called listening gears were developed and some attained a sufficient degree of success to exercise a considerable influence on the development of types of vessels from which they could be used with the maximum of efficiency. It was in fact the development of these devices in America which led to the laying down of our eagle boats, and the machinery of these boats was designed with especial view to quick starting and stopping, so that internal noises should not in any way effect the use of the listening devices. Even before our actual entry into the war, it had become evident that it would be necessary for us to produce, in the minimum of time, the maximum number of vessels of every type which could be utilized against the submarine. This led to the planning of our program of sub-chasers. Earlier in the war, the British had purchased in this country over 500 gasoline-driven wooden hull boats of 85 feet in length for general coastal use. Their experience indicated that there was a distinct field of utility for vessels of this class, but that they should be of a somewhat larger size with better sea-keeping qualities. In order, therefore, to profit by their experience and at the same time to utilize the considerable resources in this country for the construction of small wooden-hull vessels, resources which were not required in the accomplishment of any of the various other war programs, we undertook the construction immediately upon entering the war, of 350 of these sub-chasers, each 110 feet in length, about 75 tons displacement, and having three 200-horsepower gasoline engines, giving a top speed of about 16 knots. They were fitted with special facilities for the use of various types of listening gear. They carried one small gun and a number of depth charges. In their seagoing qualities, these boats more than met the anticipations of their designers. About 200 of them crossed the Atlantic under their own power and performed most useful service in the Mediterranean Sea and on the French and English coasts. However, these boats must be regarded as stopgaps rather than a type to be found in large numbers in a permanent navy.

Another class of operation which resulted in the development of a new type, or rather the resurrection with new features of an old type, was the naval operations against shore fortifications. When the Germans had occupied the Belgian coast, it became evident that the navy must be prepared to undertake operations against that coast, unless the Germans were to be permitted to remain in undisturbed possession, allowing them an extremely undesirable freedom of action by using the ports as bases for submarines and destroyer activities. To meet this condition and the possibility of

similar conditions arising elsewhere in the vast theatre of the war, the British very early put in hand a number of modernized monitors, which repeated the well-known characteristics of the early American vessels of this class; that is, slow speed, the heaviest guns, armor protection, low freeboard, and small size, but added to these a modern and efficient form of torpedo protection; the last named really forms the *sine qua non* of the modern monitor, for it must of necessity operate off hostile coasts and by its slow speed is peculiarly liable to successful attack by submarines. These monitors at intervals throughout the war carried out a series of very interesting bombardments on the Belgian coast, which were accompanied by the use of such modern methods as spotting by means of aircraft and protection by means of smoke screens, produced by small fast boats accompanying them. In general, however, these operations failed to produce any decisive results, and this experience, combined with that gained through the attempts by older British and French battleships to reduce the fortifications of the Dardanelles, has gone far to confirm the opinion held prior to the war that ships cannot compete successfully with shore fortifications.

Although not productive of new types, and not, strictly speaking, exercising any influence on naval types, it is not possible to pass over the development of the transport service during the war, as its operations were on such an enormous scale. The British conveyed to and fro from the various theatres of war a total of something like 13,000,000 men, but the great bulk of these was for short distances across the Channel. The most impressive undertakings were the combination of the American and British resources, with some help from the other Allies, in transporting to Europe nearly 2,000,000 men during the war, and the bringing of them home in a period of a little over six months by the American Navy with some help from foreign sources. The enormous undertakings demonstrated that the great passenger vessels used commercially in time of peace can be quickly and efficiently converted for use as transports, and that, therefore, the naval designer need in the future only provide for the intelligent utilization of the great mass of experience accumulated in fitting merchant vessels for this purpose. As an example of the progress made in this direction in the course of the war, can be cited the fact that when some of the large passenger vessels were first fitted for use as transports, it was thought that they had been given the maximum troop capacity. After some months of experience, however, it was possible so to modify and perfect the arrangements that their capacity was increased in some cases as much as 50 per cent.

In reviewing the use of existing novel types during the war, one cannot omit reference to the active and important part played by certain types of auxiliaries. Colliers, tankers and supply ships were used to an enormous extent, but these are of such a purely merchant type that they require no especial note, except to remark that the few colliers we had built as naval auxiliaries, with special handling appliances showed up exceptionally well. The purely naval types which demonstrated their efficiency and value were the destroyer and submarine tenders and repair ships. One or more of these vessels were stationed at each one of our principal operating bases abroad, and without them our destroyer and submarine forces would have been unable to maintain their great efficiency and high percentage of time employed in active service. Due to the shortage of shipping, it was not possible to fit out and supply an unlimited number of vessels of this type, and it soon became evident that each existing unit must be utilized to its highest degree of productivity. This led to the erection on shore at the principal bases of barracks for housing the shop operating forces, so that the ships themselves could be run 24 hours a day, using three shifts of mechanics. This development leads to the belief that in the future in certain types of operation we may be led to provide special barrack ships for carrying and berthing sufficient personnel to utilize to the full the repair facilities provided on the vessels specially fitted for that purpose.

I have previously referred briefly to the development of the new and large type of naval vessel called an aircraft carrier. In the very early stages of the war, attempts were made to attack the principal naval bases in Germany by means of aircraft, but it was found that neither the aircraft themselves nor the commercial vessels hastily fitted up for the purpose of carrying them were sufficiently developed to permit of success in such an undertaking. I cannot in this paper take up in detail the wonderful development in aircraft during the course of the war, but the technical development resulting in increased size and speed and carrying capacity are well known. These were quickly taken advantage of by naval designers to fit them for such purely naval purposes as scouting, fire control of the heavy guns of big ships, torpedo carrying and launching, etc.

The actual offensive use of aircraft against naval vessels was little developed during the war. Perhaps the most prominent case was that of the *Goeben* which was ashore near the Dardanelles, and for six days exposed to aircraft attack, it being stated that some 217 bombs were dropped against her. There is no doubt that there will be a great development of aircraft for naval use as a result of the war experience, and some enthusiasts have visions of navies of the air rendering obsolete the navies of the ocean.

The United States Navy, which has in its own hands the development and control of its aircraft for use over the water, should take lead in any air naval development; but there is no doubt that, step by step with the air offensive, there will be developed a defensive. The defensive, moreover, will not be passive. We have seen in the late war how the light craft, destroyers, etc., on one side met and countered the attacks of similar craft on the other side. Had either side been deprived of its light craft, it would have been at most serious disadvantage. Similarly, developments in the air will undoubtedly be along the line of defending the capital ship by auxiliary and offensive aircraft. The big ship which must be protected from projectiles of a ton weight falling at angles of 30 degrees, fired from ships almost out of sight below the horizon, is not yet in serious danger from bombs carried by present-day aircraft, with chances of hitting small indeed.

At the moment it appears that the torpedo plane is the most promising development; its weapon of attack is the torpedo which the capital ship must already be prepared to defend itself from, whether fired by a surface vessel or a submarine. A torpedo from a ship in the air is no more deadly than from a submarine under the surface. It seems probable that aircraft will sooner become dangerous to destroyers and the vessels generally than to the large ships of the line. The former are more vulnerable and will be less able to protect themselves.

Even these early developments of naval uses for aircraft made it evident that they could not efficiently perform such functions with the fleet unless they could be carried with the fleet, not only on long cruises but actually in battle, with the result that special types of ships have appeared to fill this requirement. The first essential of this type is that it should be capable not only of launching aeroplanes but also of receiving them back after the accomplishment of their mission. With the present development of aeroplanes and seaplanes, the only practicable method of providing the latter requirement is the provision of an enormously large and absolutely clear deck upon which the planes can light and be brought to rest. The next requirement is that such a vessel shall have a speed sufficient to permit it to keep up with the main battle fleet when it is going into action. This means a speed of 20 to 25 knots. These qualities, together with the need for sufficient space to house and care for a considerable number of planes, together with their personnel, have resulted in vessels of 10,000 to 25,000 tons displacement. To obtain a clear upper deck requires special arrangements for funnels, navigating bridges, etc., which has resulted in the only absolutely new type of naval vessels of large size and cost which has appeared as a result of the war experience.

At the other extreme among new types appearing as a result of the war, comes what have been termed coastal motor boats. These appeared more as a result of possibilities presented by modern engineering developments than as a result of the need for filling a specific naval requirement. The perfection of the gasoline motor led in the years before the war to the construction, for sporting purposes, of very light high-speed small boats. Due to the fact that they were developed primarily for racing, they were suitable for use only in comparatively smooth water and had to be handled with extreme care. A study of their possibilities by British designers, supported by the enthusiasm of young naval officers, resulted in the production of boats of 40 to 70 feet in length and capable of speeds from 35 to 45 knots an hour, each carrying from one to three modern torpedoes, and with the hulls constructed on such scientific principles that they could go to sea in comparatively rough weather, and could be hoisted on board light cruisers or other types of naval vessels. These little boats performed splendid service off the Belgian Coast, and the tale of their operations forms one of the most exciting chapters in modern naval annals. But the most spectacular, and at the same time valuable service performed by boats of this type during the war, was the daring penetration by the Italians into a fortified Austrian harbor where they sank a battleship lying at anchor. Later, in operations against the Bolshevists, a small British flotilla penetrated to the inner harbor of Kronstadt, where they succeeded in sinking two battleships and two other large vessels.

I have several times, in the course of this paper, referred to the results experienced when war vessels of older types are subjected to attack by modern weapons. During the war there were sunk by hostile action 21 predreadnaught battleships and 27 armored cruisers; of this total of 48, 11 were sunk by gunfire and 37 by mine or torpedo, only a single explosion in nearly every case being necessary to inflict the fatal damage. It is only necessary to refer briefly to such incidents as the sinking of the British battleship *Formidable*, the three cruisers *Cressy*, *Aboukir* and *Hogue*, the loss of four old battleships at the Dardanelles, the sinking of the *Gneisenau* and *Scharnhorst* off the Falkland Islands, the loss of the British *Hampshire*, and the American cruiser *San Diego* as the result of striking a single mine, together with numerous other incidents of similar nature, to show that such vessels as these, most of which were commissioned within ten years immediately preceding the war, are totally incapable of withstanding the terrific effects of present-day gunfire and torpedo attack. This showing is particularly impressive when compared to the demonstrated ability, as discussed above, of the most modern vessels to survive severe and repeated attacks. These qualities of resistance and defence can only be provided on vessels of large dimensions and displacement. The necessity for retiring these older types was well demonstrated by the fact that except for a few used for special purposes, both the British and the Germans had placed most of their older capital ships out of commission before the war had run its course.

To sum up, therefore, the experience of the war, so far as it can be grasped to date, has resulted in demands in the case of every existing type of war vessel which can only be met by increased size and cost. It has resulted in the introduction of only one new type of major importance, namely, the Aircraft Carrier, but it has introduced a number of small types which will probably survive but will not be constructed in large numbers in times of peace, as they are peculiarly adaptable to being produced quickly in large numbers after the emergency of war has arrived.

Although we must conclude that the present tendency is toward increased size and cost, one cannot overlook the fact that this very tendency, under the present financial, economic and political conditions in the world, may actually result in the long run in the disappearance from future building programs of these very types and the substitution for them of smaller and cheaper units made possible by new developments in science and engineering.

To meet this condition there never was more need than at the present time of vision and imagination on the part of the fighting forces afloat and the naval designers ashore, for that nation which can develop the weapons which will render obsolete the present great ships and can substitute for them a smaller and cheaper unit capable of defeating them will win in the new era the command of the seas, which this war has shown is so all important to ultimate victory.—*The Franklin Institute.*

THE INCREASED STRENGTH OF THE UNITED STATES ON THE SEA.—It has suddenly become apparent that our naval-building program has been steadily increasing the strength of our fleet of battleships, and that the United States Navy is at the point of surpassing the British Navy in this most important element of sea power. At the same time the British have realized the great increase of our merchant marine in comparison with Great Britain's. These revelations have been something of a shock to the British public, and many articles have been published commenting on the growth of our navy and merchant marine. Among these is a notable contribution by Archibald Hurd in the *Fortnightly Review* for June.

For many reasons, a statement of the situation from an American point of view is needed at this time. In the first place, one prevailing tendency in the British comments should be set right. Many of their writers, as is perhaps natural in the surprised realization of the change in Great Britain's position on the sea, reflect a feeling that the forward stride of the United States indicates hostility on our part and a determination to win dominion of the seas. Comparisons are made with the systematic campaign undertaken by Germany to gain the commerce of the world, which had so much to do with bringing on the World War. Mr. Hurd even sees "a menace to the peace of the world, and especially the peace of the English-speaking peoples."

Many British writers now appear to believe that America has recently changed her attitude and become hostile to the nations of Europe. The position of the United States in delaying ratification of the Peace Treaty is interpreted as meaning that America has withdrawn from association with Europe, and that this is to be followed by a national policy of aggrandizement, "a demand for nationalization," as Mr. Hurd expresses it.

The True Explanation.—It is true that the present position of the United States on the sea was brought about by conditions created by the World War, but these were straight-forward natural conditions that made an appeal to the common sense of our people. We saw the need of a larger navy for defense, and we were also suddenly obliged to build a great tonnage of carrying ships in the emergency caused by the shortage of the world's shipping at the time of Germany's U-boat campaign. These were the reasons for our naval and maritime activities. There were no underlying motives that influenced the United States.

Our Naval Program.—The circumstances of the naval increase should first be explained; it will then be evident that our present program for building warships is not the product of any recent change of policy. Our increase was determined in 1916, through the most natural causes, as will be seen when the course of events is traced leading up to the adoption of our naval-building program.

The following is the history of our naval increase: In the period of dawning suspicion and hostility which preceded the World War there was a sudden keen competition for naval superiority between Great Britain and Germany. This began in 1906, and each nation entered upon an enlarged program of building battleships. This naval activity was stimulated by the unusual condition that the capital unit of battle fleets had changed in that year to a new type, following the British design of the dreadnought, which became the name of the new all-big-gun battleship.

The adoption of this new fighting unit gave Germany an unexpected opportunity to threaten the supremacy of the British Navy, a development that would have been out of the question if the two navies had kept on in

the even course of adding battleships of the old type. In 1907, Germany laid down four dreadnoughts, in 1908 four, in 1909-1910 five, in 1911 four. In these years Great Britain was perforce obliged to respond with a corresponding increase that would maintain the existing British superiority—and this pace was continued until the outbreak of the war.

In 1906, when this great increase of building warships began, the United States held second place among the navies of the world; but, through all these years of activity, until the catastrophe of 1914, our successive Administrations adhered to the policy of restricting the building program of the United States Navy to two capital ships per year. The inevitable result was to put our navy in the third place, far behind the German Navy in number of capital ships.

Then came the World War, and the United States woke to the fact that it was comparatively weak in the most essential element for its defense, a battle fleet. So evident was this, that public opinion asserted itself, and in 1916 Congress authorized the present building program.

Purely Defensive Move.—It should be strongly emphasized that this act of the people and Congress in 1916 fixed the terms of our building program, which is now suddenly causing so much comment in Great Britain. It involved no change or threat. Our program is only the result of a timely realization among our people that our necessary defense must be a strong navy. There was, at the time, no definite thought in the public mind of using this naval force against any particular nation, although naturally the unbridled ambitions of Germany showed our need of defense. But defense alone was the object of the increase—and defense alone is the reason for its continuance, impersonal and not directed against any power.*

This instinct for defense on the seas has been most fortunately aroused in our nation. Our country is bounded by two great oceans, and the only real defense of our boundaries is the far-flung use of our battle fleet upon these wide stretches of sea. For the United States Navy, more than for any other, the ultimate service is a battle of fleets. In all human calculation, our country is safe from attack as long as we maintain a battle fleet that is able to defend our sea approaches in a naval action.

Consequently, for the United States, a battle fleet that can hold its own in an action of fleets is a necessity—and the posession of such a fleet has been insured by the building program of 1916. That is the whole story—and in this wise policy, which our country adopted four years ago, there is no trace of new influences at work "for fanning into flame the instinctive national jealousies of the two nations"—to quote again from Mr. Hurd. Any American knows that our country is barren ground for jealousy of any other nation.—*Current History Magazine*, September, 1920.

OUR DIRIGIBLE "R-38".—We understand that the American crew to be trained in England to fly back our monster airship, the R-38, has been selected. We hear also from England that the ship will be ready to commence her exhaustive trials fairly soon. It takes a long while to tune up an airship—there are so many balances to be perfected, apart altogether from engine trials and the like. The following figures which have not been published in this country before will give a fair idea of the dimensions, of the R-38, in comparison with the R-34, which flew the double Atlantic journey last summer.

	R-34	R-38
Length (in feet)	639-5	695
Capacity (in cubic feet)	2,000,000	2,700,000
Tonnage	60-7	92-0
Maximum speed	58	70

* In fact, included in the act creating the building program of 1916 there is a provision for stopping construction, if this is made possible by an adequate tribunal for arbitration.

The German airship *Bodensee*, to which so much publicity has been given, is more than one hundred feet shorter than the R-38, has a gas capacity of only 700,000, and is of 21-3 tonnage. It is claimed, however, that her maximum speed is 80. Her main disadvantage is obviously her inability to travel great distances on account of her limited gasbag capacity.—*Scientific American*, Aug. 21, 1920.

THE RELATIVE POSITION OF BRITISH AND U. S. A. SHIPPING.—The figures issued by *Lloyds' Register* a week or so ago indicate a marked change in the position of the shipping in this country and the United States of America. One June 30th a year ago the latter had about one and one-third million tons of shipping under construction over that of this country, and in six months this disparity had been wiped out, and an excess credit of twenty-seven thousand tons created in favor of Great Britain. The returns for the present year show that over three million and a half are now under construction, which is nearly one million and a half in excess of that of the United States. To show the rate of reduction, in March, 1919, just over four millions was under construction, and now fifteen months later only about two millions is the figure—a reduction of one-half. Taking the figures for this country for the same period, in March we had two million and a quarter under construction, and now we have over three million and a half, which is an increase of sixty per cent. The reasons for this change are not far to seek. The United States was persuaded by the Allies to build ships at a rapid rate as one of the most useful steps to rendering assistance in the war, and right loyally did the statesmen, business men, and manual workers in America respond. We have recorded on more than one occasion the remarkable feats of production performed, and drew attention to the stimulating effect it had on us, and the depressing effect it had had on the enemy. After the Armistice the conditions due to the war practically ceased, involving the solution of a number of difficult problems. The most optimistic of those in the United States who had long cherished ambitions with regard to the development of a Mercantile Marine on a vastly extended scale, and saw the possible opportunity when the States entered the war, recognized, on the cessation of hostilities that a number of the newly organized shipyards could not survive the new conditions. For example, a large number of yards were devoted to the building of wooden ships, and in June, 1919, four hundred and twenty thousand tons of such ships were then building, while in June this year that enormous tonnage has shrunk to twenty-nine thousand, which is about one-fifteenth the previous year's output. The United Kingdom, on the other hand, had a large number of yards engaged on warship construction, and it was more or less easy to turn the activity of the yards towards the production of mercantile tonnage. Another point that must not be lost sight of, which is, assuming a nation can produce ships, it does not follow it can man them. It will, therefore, be seen that not only could the conditions of production be rapidly changed over in this country, but we had another great advantage. For centuries, a very considerable proportion of the inhabitants of the United Kingdom have found employment at sea, and the in-born liking for the sea enables ships to be manned by those who have inherited the necessary qualifications for such service. Under these conditions we can afford to run a Mercantile Marine on a profit basis, whereas other countries find they cannot do it at all, or if they do, it is at a loss. It seems fairly evident that, however strongly some of the United States citizens desire a large Mercantile Marine, this cannot be brought about unless the national energy now being utilized so successfully in its vast and bountiful interior, and in such a profitable manner, can be diverted into other channels, which, under all the circumstances, will not happen while present conditions obtain.—*The Marine Engineer and Naval Architect*, August, 1920.

WORLD'S STEAM TONNAGE.—According to the 1920-21 edition of *Lloyd's Register of Shipping*, the world's steam tonnage amounted to 53,905,000 tons in June last. The following table shows the changes in the steam tonnage of the leading maritime nations between June, 1914, and June, 1920:

Country	June, 1920 tons gross	June, 1914 tons gross	Differences between 1920-1914 tonnage
United Kingdom	18,111,000	18,892,000	— 781,000
British Dominions	2,032,000	1,632,000	+ 400,000
America (United States)—			
Seagoing	12,406,000	2,027,000	+10,379,000
Great Lakes	2,119,000	2,260,000	— 141,000
Austria-Hungary	Nil.	1,052,000	—
Denmark	719,000	770,000	— 51,000
France	2,963,000	1,922,000	+ 1,041,000
Germany	419,000	5,135,000	— 4,716,000
Greece	497,000	821,000	— 324,000
Holland	1,773,000	1,472,000	+ 301,000
Italy	2,118,000	1,420,000	+ 688,000
Japan	2,996,000	1,708,000	+ 1,288,000
Norway	1,980,000	1,957,000	+ 23,000
Spain	937,000	884,000	+ 53,000
Sweden	996,000	1,015,000	— 19,000
Total abroad	35,794,000	26,512,000	+ 9,282,000
World's total	53,905,000	45,404,000	+ 8,501,000

Syren and Shipping has compiled the following table showing the comparative positions of the leading maritime countries in 1914 and in 1920:

1914	1920
1....Great Britain	Great Britain
2....Germany	U. S. A.
3....U. S. A.	Japan
4....Norway	France
5....France	Italy
6....Japan	Norway
7....Holland	Holland
8....Italy	Sweden
9....Austria-Hungary	Spain
10....Sweden	Greece
11....Spain	Brazil
12....Greece	Germany

—*The Nautical Gazette*, Aug. 14, 1920.

FIGHTING FOR OUR PLACE ON THE SEAS.—The opening gun of a world-wide shipping war is discerned by the *Brooklyn Eagle* in the recent offer of British ship-builders to construct steel vessels for a hundred dollars a ton less than the cost-price at which the Shipping Board is offering its ships for sale; and other papers remark that a retaliatory spirit in government and shipping circles of Japan, England, and France first manifested itself to the press of the United States soon after the enactment of the Jones Merchant Marine Act law last June. Particularly did the preferential rate clauses, which were discussed in *The Literary Digest* for July 3d, arrest the attention of foreign shipping interests, for these, according to Senator Jones, would assure to America "her rightful place on the seas." Admiral Benson, the new chairman of the Shipping Board, announces that the Board "will live up to the letter of the Jones law in spite of the

threats and propaganda carried on by foreign interests to seek to defeat the purpose of the law." He frankly resents "the secret and underhand means that are being taken to hamper the growth of our merchant marine and the development of our foreign trade"; and he declares, with emphasis, that "we shall maintain and protect our merchant marine and foster American commerce in American bottoms against any and all nations." So "all this 'bunk' is not going to scare the admiral; fighting used to be his business," says R. H. Semmes in the *Seattle Times*.

Another development which has caused freight-rate slashing, we are told, is the twenty-year agreement entered into by the American Ship and Commerce Corporation with the Hamburg-American Line, whereby a joint service "will be established to various parts of the world, and a close working agreement entered into for the mutual benefit of the two corporations," in the words of the *Washington Post*. This despite the fact that "we are technically at war with Germany," points out *The Post*. In the meantime Japan has decided to subsidize its shipping business to the extent of two million dollars, we are told, and "Britain and Germany are trading with each other almost as if there had never been a misunderstanding," declares the *Rochester Democrat-Chronicle*. So that at the present time, thinks the *New Orleans Times-Picayune*, "unfair discrimination would be a short-sighted policy to launch out on in the development of a permanent foreign commerce or a stable, adequate merchant marine." Foreign shipping interests declare that the Jones law does discriminate. And even in this country we find conflicting opinions as to just what sort of panacea for shipping the Jones law is. Admiral Benson and Senator Jones both agree that this country is faced by the question of the survival of American ships or foreign ships, and that the Jones law will protect the merchant marine which we acquired during the war. As J. J. Underwood writes in the *Seattle Times:*

"There is still much discussion in Washington about the Jones law, and the remarkable thing about it is that American ports fear they will lose foreign ships and foreign ports fear they will lose American business. But there are no two opinions about it among Shipping Board officials. They say that the only condition that can possibly be changed by the law is the substitution of American ships for foreign ships, and that if the change is made the advantage will lie with the American ship-yards, ship-chandlers, and those who deal in merchandise that American ships consume.

"They declare that American ships have had to leave foreign ports for the United States cargo-light, while British and Japanese ships plying between foreign countries and the United States have come loaded to the guards with cargo. American ships also have had trouble in getting water and fuel, while foreign ships have been accommodated. Already the word has gone forth that this discrimination against American ships must cease or the provisions of the Jones law will be made effective against those companies which practice it."

So the shipping war goes merrily on. The *Cincinnati Post* declares that the Jones law, far from benefiting the American people, "contains the trickiest little joker that ever snuggled in a mess of legislation—a combination of ship subsidy and protective tariff that will cost the United States the commercial friendship of all other nations." Furthermore, asserts *The Post*, this "joker" "will give fortunes to the owners of ships and cost the people hundreds of millions of dollars every year." But the *Minneapolis Tribune* has a different idea of the things which the Jones law will accomplish:

"The Merchant Marine Act is designed to make use of and to develop the merchant marine structure erected for war-emergency purposes. It lays down explicitly a 'policy of the United States to do whatever may be necessary to develop and encourage the maintenance of such a merchant marine.' This is a sweeping way to put it, but a policy of sweeping

character was adopted deliberately. To carry out the provisions of the bill, it will be necessary to abrogate or modify more than a score of commercial treaties with other nations. There is no halting anywhere along the line at preferential rates and terms that may be needed to make and keep the merchant marine a going concern against all comers and all competition.

"In the broadest sense the act is American in spirit, purpose, and term. It includes government encouragement, supervision, and protection, but it does not contemplate government ownership or operation. It serves notice upon the world that henceforth the United States will put its own interests foremost in its shipping laws and rules."

According to *Lloyd's Register*, of London, the gross tonnage of United States shipping has increased since 1914 until in this respect we are second only to the United Kingdom. In other words, the United States has twenty-four per cent of the world's shipping. Thus did the war provide our merchant marine. Next in order come France, Japan, and Norway. But, the *St. Louis Globe-Democrat* points out,

"The goal of our merchant-marine plan is not to secure a tonnage greater than Great Britain, and thus to become the greatest maritime nation in the world. Our object is to provide ships for American commerce, enough ships to carry all our exports and imports if possible, certainly enough to promote our export trade and relieve it of the handicap of relying upon foreign bottoms for carriage."

The *New York World's* Washington correspondent reports "an alliance of British, Japanese, and other foreign shipping interests with the view of crushing the American merchant marine, in retaliation for what is considered discriminatory provisions in the Jones law. The *Washington Star*, however, takes such a procedure as a matter of course. "We may expect vigorous competition as we go along; that is business on the water as well as on land," notes *The Star*, and its Washington contemporary, *The Herald*, admits that the act "cannot be enforced without provoking defensive and retaliatory action." The *Oakland Tribune* merely remarks that "all of these manifestations are England's disappointed and frightened outcry against America's program for achieving and maintaining independence of American maritime trade." But, points out the *New York Journal of Commerce:*

"The discriminatory sections of the law are not intended as a 'club' for use against foreign competitors, but are merely a means of compelling them to 'play fair.' It should be recognized by every one who desires the establishment of an American merchant marine that there has been gross discrimination abroad against American interests and that the 'shipping game' has been anything but fairly played by many of the foreign pools, combinations, and 'conferences.' Whether it will be possible to correct these abuses by introducing similar discriminations in the United States is, however, a very different question."—*The Literary Digest*, Sept. 4, 1920.

AERONAUTICS

PHOTOGRAPHING HAITI'S COAST LINE WITH AIRPLANES.—The present strength of the Marine Corps aviation force in Haiti is ten officers and 99 enlisted men, and the organization, Squadron E, is engaged with Squadron D, of Santo Domingo, comprising eight officers and 84 men, in making a photographic survey of the entire coast line of the island of Haiti, under the direction of the interior department of the U. S. Military Government of the island. Several officers who have completed the course in aviation at the Quantico Marine Air Station will be sent to Haiti at an early date to assist in this work.—*Aerial Age Weekly*, Aug. 16, 1920.

AEROPLANE TURRET TAKE-OFFS SUCCESSFUL.—The first flight of the new Vought aeroplane under test for the U. S. Navy from the turret platform

that the *U. S. S. Oklahoma* was successfully accomplished August 11th, and the following day four faultless take-offs were made from the turret, completing the test. The aeroplane acted satisfactorily on each trial, according to reports to the Navy Department.—*Aerial Age Weekly*, Aug. 16, 1920.

NAVY SMOKE SCREENS FROM AIR BOMBS.—Tests conducted by representatives of the Bureau of Ordnance, Navy Department, with smoke bombs designed to lay a smoke screen for naval vessels from aircraft, proved that a satisfactory screen can be laid in this manner. Experimental models of smoke bombs weighing 50 pounds were tested on August 11th, but after the experiments it was agreed that a bomb weighing not less than 100 pounds would prove to be more satisfactory for the purpose for which the experimental models had been designed.—*Aerial Age Weekly*, Aug. 16, 1920.

NAVAL FLIGHT FROM SAN DIEGO TO PANAMA.—Eighteen seaplanes of the *F-5-L* type and two of the noted *NC's*, Nos. 5 and 6, are to take part in a 3600-mile flight from San Diego, Cal., to Panama, beginning about Jan. 1, 1921. The plans for the voyage specify that 12 of the *F-5-L* design ships will be supplied by the Pacific Fleet detachment and six by the station at San Diego. The crews have not yet been selected. Air officials of the San Diego station are quoted as saying that the flight, the course of which will be down the Mexican and Central American coasts to the Isthmus, will probably be made in about sixty hours.—*Aerial Age Weekly*, Aug. 16, 1920.

NC SEAPLANES FOR FLEET OPERATIONS.—Five of the large *NC* seaplanes have been assigned to operate with the U. S. Navy fleets, three on the Atlantic and three on the Pacific. These seaplanes, carrying crews of five men each, will be employed on scouting problems and long-distance work, for which they are well adapted, being fitted for navigation on the surface and with the radio direction compass. The definite program for their employment is being worked out by the Fleet Air Detachment commanders, Captain George W. Steele, Jr., U. S. N., of the U. S. Atlantic fleet, and Captain H. C. Mustin, U. S. N., of the U. S. Pacific fleet. The *NC* seaplanes will have destroyer tenders for these operations. This is the first time seaplanes of this type have been thus employed and the work will begin before September 1.—*Aerial Age Weekly*, Aug. 16, 1920.

AMERICANS IN DIRIGIBLE FLIGHT OVER LONDON.—*London.*—The British dirigible airship *R-32* flew over London in the commencement of a twenty-four hours' instructional flight.

The airship carried the American crew which is training in England to take over the dirigible *R-38*, which has been purchased by the U. S. Navy and is under construction at Bedford.—*Aerial Age Weekly*, Aug. 16, 1920.

AIR TANKS.—July 15.—Ten armored triplanes will be built for the United States Government under a contract awarded to the Boeing Airplane Company of Seattle, construction starting at once with the first delivery scheduled in November and the other machines following rapidly before the end of the year. These planes, representing a new type of construction, are designed to serve in aerial service for ground attack, having a function similar to that of the tanks on land. They have been characterized as "flying tanks." Quarter inch armor plate protects the fuselage and nacelles. The armament includes a thirty-seven millimeter rapid fire gun mounted in front, four machine guns trained to fire through the floor, two machine guns at the back and two above the wings.—*Flying*, September, 1920.

GREAT LAKES HAS LARGE AVIATION SCHOOL.—Nearly 100 men are being graduated every three weeks at Great Lakes Naval Training Station from what naval officers describe as the biggest trade school in the world.

The school is devoted exclusively to the training of aviation mechanics and at the present time 3225 students are taking the courses, which range in length from 16 to 36 weeks.

More than 1000 men have graduated since the school was established slightly more than a year ago and another 1000 will complete their work by November. Lieut. Commander E. E. Wilson, commandant at the school, says all of the 6000 men provided for in the naval air force will be graduates of the school within another year.

The cost of turning out the first 1000 graduates was $7000, making the average cost of producing trained aerial mechanics $7 each. The low cost was due to the fact that the students produce nothing in their studies to be wasted. Instead of making the frequently useless examples they work on parts actually needed for repairs and construction of new aeroplanes.

A number of planes ranging from small land flyers to huge seaplanes, only a step smaller than the famous *NC* type, have been completed.

Lieut. Commander Wilson started the school from the bottom a year ago. As the first step the navy officer wrote all the text books to be used.

No flying is done but the best men from each class are eligible later to attend a school for enlisted pilots. The 3225 students now here include 440 marines.—*Aerial Age Weekly*, Aug. 8, 1920.

ENGINEERING

THE ELECTRICALLY-WELDED SHIP "FULLAGAR."—The motor coasting vessel *Fullagar*, which has recently been completed by Messrs, Cammell, Laird & Co., Ltd., Birkenhead, is noteworthy both on account of the employment of electric welding in her hull construction, and because she is the first vessel to be fitted with the Cammellaird-Fullagar type of marine oil engine.

The leading particulars of the ship are:

Length B. P.	150 ft. 0 in.
Breadth moulded	23 ft. 9 in.
Depth moulded to main deck	11 ft. 6 in.
Depth moulded to raised quarter-deck	15 ft. 6 in.
Load draft	11 ft. 4 in.
Load deadweight, about	500 tons
Cargo capacity, about	25,000 c. ft.
Speed	9½ knots

In general arrangement the vessel is of the ordinary coasting type.

The electric welding has been carried out on the "Quasi-Arc" system, introduced by the Quasi-Arc Co., Ltd., of London, who have carefully supervised all welding operations, as have also the representatives of *Lloyd's Register* of Shipping, with which society the vessel is classed.

The main engine is of the Cammellaid-Fullagar opposed-piston type, and is capable of developing about 500 B. H. P. when running at 100 to 120 revs. per minute. The engine has four cylinders 14-inch diameter, each piston having a stroke of 20 inch, and working on the Diesel cycle. Air at a pressure of 1000 lbs. per square inch is used for injecting the fuel into the cylinders. A three-stage air compressor is driven from the forward end of the crankshaft, and the circulating pumps are arranged forward of this again, thus rendering the engine a self-contained propelling unit. The saving in weight and space effected by this type of engine is considerable.

On the 28th June trials of the vessel were carried out in the River Mersey, in the presence of a large number of engineers and shipbuilders from all parts of the country. The ease and quickness with which the engine could be maneuvered impressed all present. Front full speed ahead to full speed astern only required about ten seconds, the engine easily starting action with full ahead way on the ship.

At about 11-40 p. m. on the same day the vessel started on her maiden trip to the Clyde. After getting clear of land extremely rough weather was encountered; and as this became worse, it was found necessary to put into Ramsey until the storm abated. During this part of the voyage the engine ran steadily throughout, no racing being experienced, and there was only a slight variation in the revolutions. The hull was well tested, and withstood perfectly the severe shocks and stresses experienced through the force of the waves.

The vessel left Ramsey at 4.20 a. m. on the 1st July, and reached Greenock about 6 p. m. The engine continued to run steadily at a speed of 106 r. p. m., the ship doing about 9.75 knots per hour against wind and tide.

On the 2d July, a large party of Clyde ship-builders and engineers were present and witnessed trial runs on the mile and maneuvering tests. All expressed satisfaction at the running of the engine and the promptitude and satisfactory manner in which orders from the bridge were executed.

The *Fullagar* left the Clyde at 11.30 p. m. the same day, and arrived in the Mersey at 8 p. m. on the 3d July. The engine ran satisfactorily and without sign of trouble at an average speed of 107 r. p. m., the vessel averaging about ten knots. During this run the fuel consumption worked out at 2.1 tons per day of 4 hours.

Some of the readings from the engine were as follow:

Scavenge air pressure	1¼ lb. per sq. in.
Circulating water pressure	6.5 lb. per sq. in.
Lubricating oil pressure	12 lb. per sq. in.
Blast air pressure	1,000 lb. per sq. in.
Scavenge	50° F.
Circulating discharge temperature	100° F.
Engine-room temperature	62° F.

—*The Shipbuilder*, August, 1920.

CONCRETE SHIPBUILDING.—It can be stated with fair certainty that reinforced concrete will not replace steel for ordinary cargo carriers unless the hull can be built for considerably less than half the cost of building the same hull in steel.

Where the additional weight is more than counter-balanced by the durability and reduced prime cost of the new material there is reason to expect that its adoption will naturally follow. The lower first cost of concrete vessels is partly due to the fact that no heavy plant is required for reinforced concrete work, partly due to the relatively lower cost of the reinforcement, as compared with other forms of steel and partly to the lower rates of wages paid to the men employed. The saving in the cost of steel seldom exceeds 50 per cent. On an average the cost of a concrete hull is about 70 per cent of that of a steel hull of the same dead-weight capacity.

In the case of pontoons the cost of construction (prior to 1914 was found to be about one-half, and the cost of maintenance and repairs only one-quarter to one-third that of similar structures in steel. (A. B. Searle, *Concrete and Constructional Engineering*, July, 1920.)—*The Technical Review*, August 17, 1920.

THE MOST POWERFUL GAS ENGINE IN THE WORLD. (*La Nature*, June 19, 1920.)—This distinction is claimed for an engine made by the Crockerill Society in Liege, Belgium. In August, 1914, it was in process of erection. The Germans after the capture of the city allowed it to be put into operation and, when they were assured of its success, took it from its owners and sent it into Germany, to Duisburg, where it was running at the time of the Armistice. It was then sent back to Liege, where it was installed for the second time, with the addition of some improvements. It develops 8000 horsepower. The cylinders, four in number, are 1.3 m. in diameter, 1.5 m.

stroke, 94 r. p. m. The heat of the gases coming from the engine is used to generate steam for a turbine.—*The Franklin Institute*, August, 1920.

NEW BETHLEHEM FUEL-SAVING DIESEL ENGINE.—Once more Charles M. Schwab appears in print with a statment of vital interest to ship operators. This time it is an announcement of a new type of Diesel engine representing, says Mr. Schwab, a greater advance over the oil-fired steamer than the latter represents over the coal-fired vessel.

Mr. Schwab's statment reads as follows:

"It is a great pleasure for me to announce a new two-cycle fuel-saving marine Diesel engine especially designed for American operating conditions and adapted to land use as well as cargo vessels of any size. In the science and practice of marine engineering this new engine represents a far greater advance over the oil-burning steamship than the latter is over the coal-fired steamship. It is also regarded as a signal triumph for American engineering skill in a field hitherto dominated entirely by Europeans.

"The development of the new Bethlehem fuel-saving Diesel engine represents two distinct phases of advance in marine engineering:

"1. For the first time an internal combustion heavy oil engine for either marine or land uses has been perfected which is not only designed and built by Americans, but is built especially for Americans, and is adapted to American operating conditions.

"2. For the first time a two-cycle internal combustion heavy oil engine has been perfected which produces the same horse-power as a four-cycle engine practically twice its size, and is at the same time adapted to large cargo ships while saving two-thirds in fuel cost alone, as compared with steam-driven, oil-fired vessels.

"Neither of these developments is theoretically a new idea. For years Europeans have successfully operated large ships with Diesel engines. The achievement of Arthur West, the Bethlehem designer, who is at the head of our power department, is in the adaptation of the two-cycle engine to American operation and in the perfection for practical use in cargo vessels of any size.

"The success of this engine has already been demonstrated in two ways. It was installed and operated for ten months as part of the power plant of the Bethlehem Steel Corporation at Bethlehem, Pa. It was then installed in our new ore-carrying vessel, the *Cubore*, which to-day completed on regular schedule time its first voyage to Cuba and return.

"The operation of the engine at the Bethlehem plant was so successful that we are building another one to take its place as part of the auxiliary power plant for the steel mills. Its operation on the *Cubore* not only demmonstrated its practicability but its remarkable economy. The *Cubore* made the voyage from Sparrows Point, Md., to Cuba and back without stopping her engines except to come into port and consumed one-third of the amount of fuel oil ordinarily used by her sister vessels fitted with oil-burning steam machinery of the usual type when running on this same voyage and at a much greater rate of economy than has been achieved by any other Diesel engine operated ship of which we may have any record.

"We also have in service between here and Cuba duplicate ships, except that some are fitted with turbine reduction gears and some with reciprocating engines so that we have a direct comparison between the oil engine installation and the most modern steam installation."—*The Nautical Gazette*, Sept. 2, 1920.

ORDNANCE

NEW LIGHT ON THE JUTLAND BATTLE.—Many and varied have been the theories advanced to account for the practical immunity enjoyed by the German High Seas fleet in the Jutland action. The attempts to reconcile our undoubted victory with our heavy material losses have, in many cases, been very wide of the mark. A careful study of the official documents on

both sides, bearing in mind the actual state of affairs with regard to the personnel and material of both the British and enemy fleets reveals the fact that the elements which contributed to our losses have, to a large extent, been overlooked by the critics.

Our heaviest losses occurred in the battle-cruiser action between Beatty and von Hipper's squadron, before either of the main fleets joined in the fight. Our forces were, on paper, immeasurably superior to the German, and it was not long before our ships of the *Warspite* class came to their support. Thus we had 32 15-inch guns and 32 13.5-inch guns in action at this phase of the battle, whilst the heaviest piece mounted in any of the enemy vessels was the 12-inch. Yet we lost the *Queen Mary* and the *Indefatigable*, the former one of our finest battle-cruisers, right at the outset, whilst the Germans only lost one modern capital ship, the *Lutzow*, during the entire course of the battle.

Going into the matter more closely, it will be found that the German ships received a most terrific hammering, however, and that the majority of the British craft came through a series of sanguinarily contested actions almost scathless. Our guns were better, our shooting was probably better, and our morale was certainly far better than that of the enemy. Yet, at a later stage of the action, we lost another battle-cruiser, the *Invincible*. In face of these facts, it is no wonder that such difficulty has been experienced in accounting for the heavy losses on the British side. Viscount Jellicoe has been blamed on account of imagined weakness in both strategy and tactics and has generally been made the scapegoat for failures and shortcomings over which he could nowise have had any control.

Whitehall was entirely to blame for both our failure to inflict more heavy damage on the German High Seas fleet and for our own losses. With our splendid secret service and our very efficient gunnery experts, there was no excuse at all for the blunder made in the designing of our ships of the line and for the failure to fit them to attack and to resist attacks of the only fleet they would have to encounter. For that was the cause of the *Queen Mary* and *Indefatigable* disasters and the reason why the *Lutzow* was the only German capital ship to be sunk. Ship for ship, on paper, the British seemed to be superior, and their numerical advantage in the battle overwhelming. Actually, the Germans were so superior that the greatest numbers of Jellicoe's fleet was more or less nullified and by withdrawing at the right moment, von Scheer was able to avoid the real defeat which Britain expected the Grand fleet to inflict upon him.

All our naval artillery had been designed with a very high velocity, consequently with a long range at a small angle of elevation and a correspondingly large danger space. To combat this, German capital ships had been provided with very stout vertical armor. In addition, they had a more minute internal sub-division, a better disposition of their magazines, and thick horizontal deck armor, funnel glacis and turret roofs to afford protection from our heavy shells, descending at steeper angles at the long ranges at which it was anticipated the British guns would be brought into action.

On the other hand, the German theory differed widely from our own. Their guns were lighter and shorter, and their velocity was lower. But their mountings were designed to give a very great angle of elevation and their effective range was as great as that of our heavier pieces. In order to obtain accuracy at these long ranges, they had developed range-finding and fire control to an extent which was never realized in this country until hostilities had ceased. Their guns were of an accuracy that was deemed impossible for a "built-up" weapon and they calibrated them so as to give no spread or a salvo.

These facts were known at the Admiralty before the war started and we had ample proof of them in the early actions. Yet the *Hood* was the first, and is still the sole ship, flying the White Ensign to embody in her design an effective form of defence against these tactics. Our ships had a

minimum of horizontal protection and our range-finding was of an order that made shooting at anything like the extreme range of our guns very much a matter of chance.

In the *Hood*, many of the features of the German battle-cruisers interned at Scapa Flow in 1918 have been embodied. She embodies ideas of protection against a "plunging" fire, and is sub-divided and strengthened very much as was the *Hindenburg*. The peculiar thing about it is that every naval power but Germany copied us in adopting high velocity guns. And now we have mounted our armament on their lines, so as to give a big angle of descent to the projectile at the target end, as have the Americans in their newest battleships. The numerous long-base range-finders in the *Hood* were in use in the German fleet before the Jutland battle.

The German policy of ship design and their artillery scheme were both thoroughly vindicated in the Battle of Jutland, just as the British were shown to be faulty. Strategically and morally von Scheer was badly beaten off the Horn Reef on the fateful 31st of May, four years ago. Officers and men on both sides performed epic deeds of gallantry. But since then we have had time to find out just how our "expert" advisers had muddled and bungled and how they had "let down" those gallant men who fought the stern fight in the watery wastes of the North Sea.—*Marine Engineer and Naval Architect*, August, 1920.

THE ERRORS OF MEASUREMENT IN RANGE-FINDERS.—The usual expression for the error of measurement in the case of a range-finder is: $f = \pm e^2/b.v.20{,}000$ where e is the measured distance, b the length of base, and v the magnification of the instrument.

For the accuracy of vision an angular value of 1/20000, corresponding to about 10 seconds, is fixed upon. The value of f given by the above formula is known as the "minimum error"; in practice a value equal to four times this minimum error is introduced and known as the "allowable error." The accuracy of range-finding depends, however, on other factors than the ones just mentioned. The form of the object, the weather, the type of setting, and the personal equation of the observer are some of the things that affect the accuracy of measurement. Taking these things into account, the author develops the formula

$$f = \pm k(1-\alpha^{-e})(e^2/b \,.\, v) \,.\, \delta$$

where k is a factor depending on the type of instrument, α is an absorption coefficient taking account of the weather, and δ is a factor which includes the effect of personal error and the change in the physiological limiting angle caused by the constitution of the object; in the best cases δ falls to the value of 10 seconds. If the object is in motion an additional factor $(1+\lambda\omega^2)$ is introduced into the formula, where ω is the regular velocity of the object in the direction of the line of division in the field of view of the range-finder, and λ is a constant which depends on the kind of instrument and on the dexterity of the observer. The value of 10 seconds, which from experience has been assumed to be the value of the accuracy of vision, cannot be considered as constant. From a consideration of the effect on the retinal rods and cones it is to be expected that the longer the object is (within certain limits), the greater the accuracy of setting should be, owing to the fact that a greater number of retinal elements are brought into action.

In order to test the effects of size and form of the object a number of experiments were carried out. Two black rectangles of variable height and of breadth 50 mm. were set up on a white background. They could be moved sideways relative to each other distances of from 1 to 5 mm. If observed with the unaided eye at a distance of 20 meters a displacement of 1 mm. would correspond to the physiological limiting angle of 10 secs. In order to prevent the measurements from being influenced by the observer's other eye, binoculars having magnifying powers of six and eight

were employed at distances of 120 and 160 meters respectively from the object, one of the objectives being in each case covered. In this way errors due to accommodation were eliminated. For each set of measurements at least 50 trained observers were employed. The percentage number of correct estimations, corresponding to various heights and relative displacements of the rectangles are given in Table I.

TABLE I. TABLE Ia.

Observation with 6 × binocular at distance 120 meters.
Breadth of rectangle 50 mm.

Height in mm.	10	20	30	40	10	20	30	40
Displacement 1 mm.	25	31	34	29	.22	.28	.31	.26
" 2 "	35	50	56	55	.16	.24	.27	.27
" 3 "	25	57	72	77	.07	.19	.22	.17
" 4 "	28	63	78	82	.06	.09	.17	.24
" 5 "	35	68	87	82	.06	.14	.21	.19

It follows that, at least for the larger displacements, there is an increase in the certainty of observation with increase in height of the object.

When an observer endeavors to set for coincidence, as in range-finding, the errors of observation will in magnitude and distribution follow the laws of probability. The probability 0.5 will then correspond to the limit of the region of certainty, and therefore to the magnitude of the " minimum error." Now, for a given displacement s the probability that a setting will be within the region of the displacement is given by

$$W = \frac{2h}{\sqrt{\pi}} \int_0^s e^{-h^2x^2} dx$$

where h denotes the coefficiency of accuracy. The same formula holds for the probability that a large number of observers, for a given relative displacement of the rectangles, will estimate the displacement correctly. Table Ia gives the values of h calculated by means of the probability formula from the results of Table I. It can be seen that for a constant value of the ratio of height to displacement the value of h is constant and that with increase in this ratio h increases up to a more or less constant value. In the case of the rectangles of breadth 50 mm. the physiological limiting angle was found to be about 20 seconds, whereas with rectangles of breadth 10 mm. the value was about 14 seconds, which is in good agreement with Wulfing's result, namely, 12 seconds.

Observations were also made with objects in the form of gratings and with black rectangles having white lines down the middle. In the latter case it was found that for low values of the height the accuracy was less with the white center lines than without, whereas it was greater for heights of 60 mm. or more. Further observations showed that the accuracy of setting increases, the more nearly the partial objects are normal to the line of division. It was also found that the triple field type of setting (central strip) does not greatly increase the accuracy over that obtainable with the double field type.

The author develops empirical formulae connecting the coefficient of accuracy with the height of the partial objects and their relative displacement and the conclusion reached by the author is that with the usual forms of objects the " minimum error " may be taken as 10 seconds, but with partial objects inclined towards one another at an angle of 45° the error increases to 13 seconds. (Dr. Hans Schulz, *Zeitschrift für Instrumentenkunde*, Mar., Apr., Aug., 1919.)—*The Technical Review*, Aug. 3, 1920.

THE PRESSURE DISTRIBUTION ON THE HEAD OF A SHELL MOVING AT HIGH VELOCITIES. (L. Bairstow, R. H. Fowler, and D. R. Hartree. *Proceedings of the Royal Society*, A 684, May 1, 1920.)—The problem proposed to themselves by the investigators was one of great difficulty. Any kind of registering pressure-gauge placed within the shell would need to be insensible to a spin of 11,660 r. p. m. and to the shock of landing. This difficulty was avoided by employing a service time-fuse as a manometer. The rate of burning of such a fuse depends on the total external pressure on the vents. In the fuse a train of gunpowder is ignited by a detonator pellet by the shock when the gun is discharged. The time of burning is taken as the interval from the discharge of the gun to the explosion of the shell.

In the experiments shells were fitted with caps enclosing the fuses. In each cap was a series of holes equidistant from the nose of the shell. The relation between rate of burning and pressure was obtained from a set of experiments made with a fuse body mounted on the shaft of a Laval turbine and run in an air-tight box in which the pressure could be varied.

A series of shells provided with caps pierced with holes was fired along the same trajectory at brief intervals and the time of burning of the fuses was noted. From this and the length of the fuse the rate of burning was deduced and in turn from the rate of burning the pressure was derived at the part of the shell where the holes were located. This last step was made by reference to the laboratory experiments under varied pressure. "At all speeds in the range covered the pressure has a maximum positive value at the nose of the shell. The pressure falls rapidly as the point of observation moves toward the base, and is negative some distance before the cylindrical part of the shell is reached."—*The Franklin Institute*, August, 1920.

NAVIGATION AND RADIO

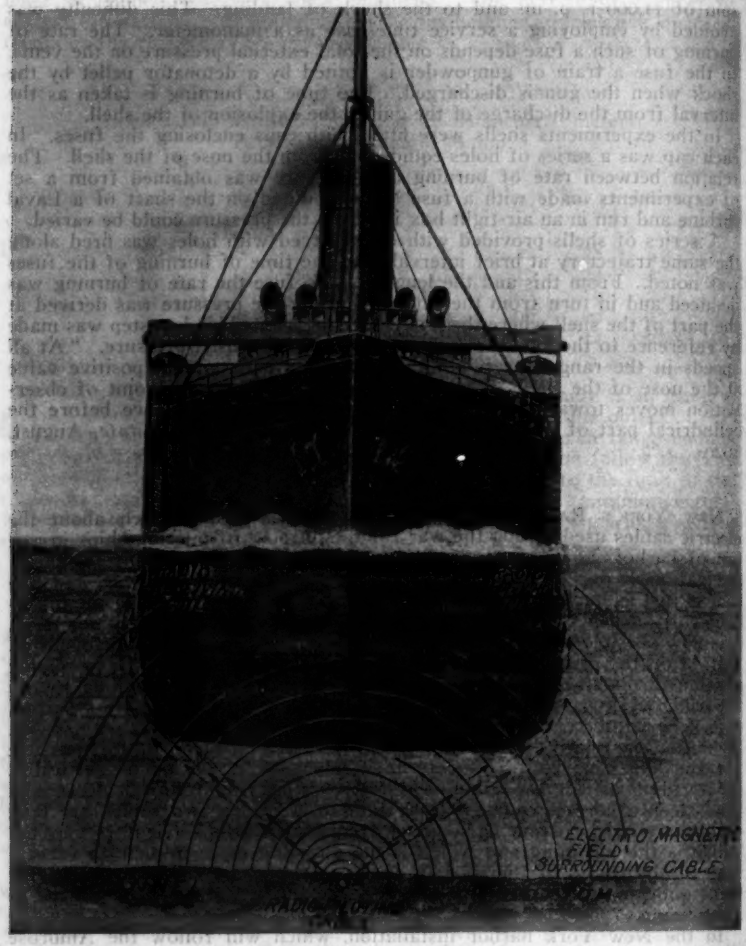
NEW YORK'S RADIO PILOT CABLE.—Much has been written about the electric cables used during the war for the purpose of piloting ships in and out of harbors at night. Indeed, it now appears as though this system of navigation is one of the greatest benefits derived from the war, and one that is just as important in peacetime as in war. However, with the installation of such a system in New York harbor by the United States navy, it is now possible to give exact details of how the radio pilot cable operates.

In brief, the principle of the radio pilot cable, as it is called, is to employ a cable through which flows alternating current. Ships intending to use the cable while passing in or out of waterways are provided with a pair of coils which intercept the electromagnetic waves emanating from the cable. By noting the relative strength of the waves reaching each coil, it is possible for the ship's navigator to determine when he is astride of the cable. Once riding astride the cable, it is relatively easy to follow it along and thus steer a correct course. In certain installations two cables are laid, each carrying a current of a given frequency. Ship navigators can tell which is the incoming and which is the outgoing cable by making careful note of the sound of the waves. In this manner a route is provided for ships going in either direction, and the chances of collision are reduced to a minimum.

In the New York harbor installation, which will follow the Ambrose Channel, one type of cable has been specified. This cable consists of seven strands of No. 16 tinned copper wire insulated with a layer of 30 per cent Para rubber 3/16-inch thick, over which is wrapped a layer of tape and jute, impregnated with a water-proof insulating compound. Over this layer of jute is an armor which consists of a wrapping of No. 12 galvanized steel wire. The overall diameter of this cable is approximately one inch. Some 87,000 feet of cable will be required.

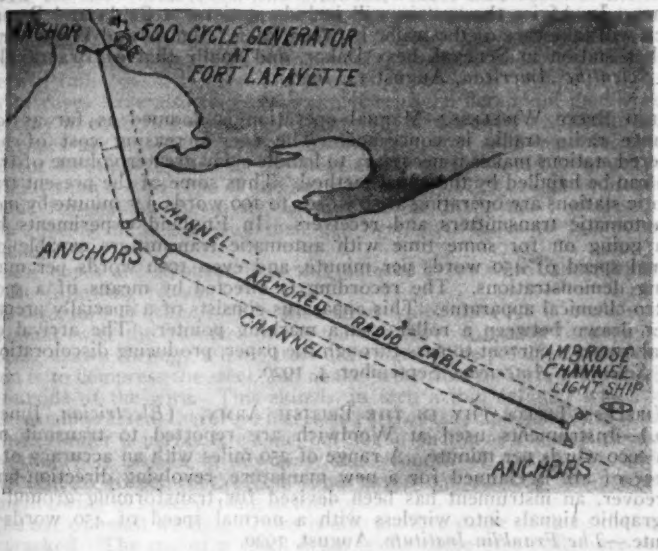
There will be two anchors secured to the extreme end of the cable and only one anchor will be used at each of the three other points along the cable.

A one-killowatt motor-generator will be used for supplying 500-cycle alternating current to the cable. The voltage may be either 125 or 250 volts. Provision will have to be made for driving this generator from local source of current supply so as to maintain the motor-generator set at a



constant speed. It is obvious that a fluctuation in the speed of the generator results in a change of note, which is apt to cause much confusion when using the cable. The amount of current flowing in the cable will be under control at all times and will range from one to eight amperes. A telegraph key is to be installed for the purpose of breaking the cable current in order to transmit signals; in fact, an automatic sending apparatus may be installed so as to send out given signals over and over again when necessary.

So much for the cable. Now the receiving end aboard ship is quite as simple. Two coils are required, each four feet square and wound with 400 turns of No. 24 S. C. C. copper magnet wire. Care should be exercised in making these coils so that each coil will have the same resistance and inductance values. Much depends upon this precaution as the signal strength received by each coil is the function of the resistance of each coil, and should their resistance be different, a signal strength of different intensity will be received by each coil when at the same distance from the cable. The best shape for the coils is the pancake. The wire can be wound in pancake form four feet square, with a winding space of one inch. The coils are impregnated in paraffin and then placed in wooden boxes with more paraffin in order to protect them from abrasion.



The coils should be placed over the side of the ship approximately amidship, one coil on one side and the other coil on the opposite side, below the surface of the water or slightly above the water line.—*The Scientific American*, Aug. 28, 1920.

THE LARGEST WIRELESS STATION IN THE WORLD.—The Radio-Corporation of America has purchased 6000 acres near Port Jefferson (Long Island) for the erection of what will be the largest wireless plant in the world.

Seventy-two towers will be employed, and it is said that the Alexanderson high frequency alternator system is to be used with multiple antennæ. This system requires relatively small generating plants and towers only about 400 feet high. The report states that communication will be established with South America, Germany, France, Italy, and Poland, and that each unit will have a speed of 100 words per minute, thus permitting a total transmission of 500 words per minute with simultaneous reception at the same rate. According to an official statement by the company this report is premature. (*Electrical World*, May 22, 1920. ½ col.)—*The Technical Review*, August 3, 1920.

FRANCE'S WIRELESS PLANS.—A dispatch from Paris states that the French Government has recently announced plans for an elaborate wireless system whose center will be in Paris and which will cover Europe, Asia, Africa and South America and connect with North America. If this system, part of which is already in existence, is integrally applied as now proposed, France's wireless communications throughout the world will be able to rival with Great Britain's cable communications. According to the details made public at a recent meeting at Rennes, wireless communication was established with Hungary May 20, 1920, and will soon be opened with Belgrade. For commercial communication with the United States there is a station at Doua, near Lyons, in addition to the Lafayette station near Bordeaux. Between France and its colonies there will be stations with a range of 7500 miles at Caigon and at Tahiti. Stations with a radius of at least 4375 miles will be established at Djibouti, Tananarivo, Noumea, and French Guinea. In Africa the system will include stations at Saida and Bamako, which will take care of the traffic between Paris, Algeria and West Africa; another station in Senegal, near Dakar, and finally that of Brazzaville.—*The Scientific American*, August 14, 1920.

HIGH SPEED WIRELESS.—Manual operation is doomed as far as long-distance radio traffic is concerned. The ever-increasing cost of high-powered stations makes it necessary to handle a far greater volume of traffic than can be handled by the usual method. Thus some of the present trans-atlantic stations are operating at 50 words to 100 words per minute by means of automatic transmitters and receivers. In England experiments have been going on for some time with automatic transmitters capable of a normal speed of 450 words per minute, and even 1000 words per minute during demonstrations. The recording is effected by means of a special electro-chemical apparatus. This apparatus consists of a specially prepared paper drawn between a roller and a marking pointer. The arrival of a signal causes a current to pass through the paper, producing discoloration.—*The Scientific American*, September 4, 1920.

WIRELESS TELEGRAPHY IN THE BRITISH ARMY. (*Electrician*, June 25, 1920.)—Instruments used at Woolwich are reported to transmit more than 2000 words per minute. A range of 250 miles with an accuracy of one degree of arc is claimed for a new maniature, revolving direction-finder. Moreover, an instrument has been devised for transforming ground line telegraphic signals into wireless with a normal speed of 450 words per minute.—*The Franklin Institute*, August, 1920.

MISCELLANEOUS

WORLD'S DECREASING COAL OUTPUT.—Figures compiled from official sources show that the world's production of coal for the last completed year, 1919, stood at the lowest figure since 1910. The total production last year was 1,170,000,000 metric tons, lower by 10,000,000 than the figures for 1910 and a decrease of 171,000,000 tons as compared with the year 1913. The figures of the world's coal production for the last seven years are as follows:

	Metric Tons
1913	1,341,000,000
1914	1,208,000,000
1915	1,190,000,000
1916	1,270,000,000
1917	1,336,000,000
1918	1,332,000,000
1919	1,170,000,000

Great Britain is responsible for very nearly one-third of this enormous decrease in production, her output having dropped from 292,000,000 metric

tons in 1913 to 237,000,000 tons in 1919. Belgium's production dropped by the best part of one-fifth of its 1913 total, whilst the French production fell by one-half from 44,000,000 tons to 22,000,000.—*The Nautical Gazette*, Aug. 14, 1920.

EXPERIMENTAL DISTILLATION OF KELP AT LOW TEMPERATURES.—G. C. Spencer, *Journal of Industrial and Engineering Chemistry*, 1920, has made 16 distillations of dried kelp in an oil-jacketed wood retort at temperatures not exceeding 320° C. Aqueous liquor, tar, and a non-inflammable gas were obtained. The residual charcoal was not sufficiently heated for the good extraction of potash or for use as a filtering medium, therefore kelp must be distilled at a much higher temperature.—*The Franklin Institute*, August, 1920.

WIRE ROPES: THEIR USES AND MISUSES.—Steel wire ropes in the hands of competent men are in most cases better and safer than chains, however well made. The strength of a chain is the strength of its weakest link, whereas if a strand in a wire rope breaks, it does not mean that the whole rope will fail.

Wire ropes have also to a great extent replaced hemp and manila ropes, especially in countries where the climate has a bad effect on the latter; the wire ropes are less cumbersome for hoisting, etc. For instance, a hemp rope for hoisting sections in the erection of masts would be much more unwieldy than a steel rope of the same strength. They are also much more suitable for staying the masts, as they can be made taut; whereas, if a hemp rope is made taut and then gets wet, it is liable to fail owing to shrinkage.

These ropes are stronger than the material from which they are made, for the following reason.

Manufacture of Ropes.—The wire from which the rope is made up is at first about twice the diameter of the finished wire; it is then reduced in size by being drawn through a hard steel drawplate. The result of this drawing action is to compress the steel, and at the same time to form a hard skin on the outside of the wire. This skin is, in fact, a thin cylinder which keeps the steel compressed, therefore increasing the density and hence the strength.

This cylinder is perfectly elastic, but not so ductile as the steel inside. If the cylinder is broken in any way, the strength of the rope is reduced 5 per cent to 10 per cent. New ropes are often reduced this amount in strength owing to kinks getting in the rope.

The use of small winding drums is also another cause of this skin becoming cracked. The use of a small drum is the cause of a still more serious action. A rope may pass round a small drum or pulley perhaps a thousand times, and then suddenly fail, the reason being the repeated bending of the wire. So that while kinks usually only reduce the strength of the rope, the use of small winding drums or pulleys is even more dangerous. Steel wire ropes are more flexible than iron ones, but a bad kink will do more harm to a steel rope than to an iron one, as the iron rope is more ductile.

This damaging action by bending depends also on the speed of the winding drum or pulley over which the rope passes. For slow speeds the size of drum should not be less than 80 times the diameter of the rope, and for high-speed winding 120 to 150 times the diameter. Guide pulleys may be less, as the rope does not pass all the way round them. They should never be less than 50 times the diameter of rope.

The weakest point in a rope is at the capping, or where it is attached to the crane hook, or to the anchor in the case of a stay for a mast.

Methods of Capping.—The best method of capping, in fact the only satisfactory method, is as follows:

About 6 inches from the end, the rope is seized. The wires are then frayed out, well cleaned, and put into a cone-shaped casting; then white metal is run in. The efficiency of a rope capped in this way is from 95 to 99 per cent.

Some engineers object to this method of capping, on the ground that the hot white metal anneals the steel. This objection is dealt with in the following manner. It has been proved by experiment that steel is neither reduced in strength nor in hardness, unless it is heated up to the recalescence point, this point being 1441° F. for ordinary purposes. The white metal used may be melted at a temperature of 700° F., and so does not anneal or reduce the strength of the steel in any way whatsoever.

The efficiency of a spliced rope is from 60 to 80 per cent, depending on the man who makes the splice.

The method of capping a rope by splicing a thimble into the end is usually quite good if made by an experienced man. A straight splice is in general nearly as strong as the rope itself, but when it is bent to take the thimble, the wire is not uniformly loaded, so that if it were spliced for double the usual length, it would not be anywhere near the strength of the rope.

The first method also has the advantage that it does not require skilled labor as is the case with a spliced capping.

The efficiency of ropes using the various kinds of screw-grips is from 30 to 50 per cent. The use of any type of grip which tends to deform the rope is bad practice; in the first case, because it crushes the rope, and secondly, because the rope is not uniformly loaded.

The efficiency of a rope is worked out in the following manner:

The rope is first fractured in the testing machine in the usual manner. Then each separate wire is fractured in a smaller machine.

$$\text{Efficiency} = \frac{\text{Total load required to fracture rope}}{\text{Sum of the loads required to fracture each wire.}}$$

Example.—A rope consisting of 49 wires failed at 20 tons.

Each of the 49 wires failed at cwt. 9.

$$\text{The efficiency percentage} = \frac{20 \times 20 \times 100}{9 \times 49} = 92.70$$

Laying of Wire Ropes.—Wire ropes are laid up in two different ways. (1) Ordinary lay. The wires in the strand are laid right-handed, and the strand laid up left-handed in the rope. Ropes laid up in this manner are cheaper to make, and are, or should be, only used for stays and guys, and never for hoisting; the reason being that they wear out very quickly owing to only a small proportion of the wires coming in contact on the drum. (2) Lang's lay. In this method the wires in the strand and the strand in the rope are both laid up in the same way, and hence have a smoother surface and no sharp corners as in the ordinary lay. This rope wears uniformly.

No general formula can be given for the strength of wire ropes, for the simple reason that they vary so much with different makers.

If first-class ropes are used, however, the following are sufficiently accurate:

C = Circumferences, measured in inches.

Breaking load in tons = $3\,C^2$ (steel).

Breaking load in tons = $3\,C$ (iron).

The following is an actual test on a steel wire rope, 4 inches in circumference:

Actual breaking load in tons = 51.7.

From $3\,C^2$ breaking load in tons = 48.0.

so that if dealing with first-class ropes the $3\,C^2$ is quite safe.

For dead loads, such as the load on a mast stay, the safety factor may be taken as five. For live loads, for instance, the rope used to hoist sections in the erection of masts, a safety factor of at least eight should be used. When paying out rope from a coil it should always have the twist taken out as it comes off the coil, otherwise kinks will result; and it should always be laid out flat before being wound on the winch drum.—*Engineering and Industrial Management*, August 19, 1920.

CURRENT NAVAL AND PROFESSIONAL PAPERS

Products of Detonation of TNT. *Proceedings of the American Philosophical Society.*

The Wisenant Longitudinal Aeroplane. *Aerial Age Weekly,* Aug. 23, 1920.

Duralumin. *Aerial Age Weekly,* Aug. 16, 1920.

Mobile Artillery and Aircraft. *The Journal of the Royal Artillery,* July, 1920.

The Ice Patrol. *The National Marine,* August, 1920.

Alloyed Aluminum as an Engineering Material. *Journal of the American Society of Mechanical Engineers,* September, 1920.

Submersible Electric Motor Pump. *Engineering,* Aug. 27, 1920.

The Engineering and Allied Industries of Canada. *Engineering,* Aug. 20, 1920.

The Force and Power of Waves. *The Engineer,* Aug. 20, 1920.

Geared Turbines With Double Reduction Gear. *Engineering,* Aug. 13, 1920.

The World's Merchant Shipping. *Engineering,* July 30, 1920.

The Efficiency of Propulsion of Full-Sized Ships. *Engineering,* Aug. 6, 1920.

Gravitation and Relativity. *The Journal of the Franklin Institute,* August, 1920.

NOTES ON INTERNATIONAL AFFAIRS

FROM AUGUST 10 TO SEPTEMBER 10

PREPARED BY

PROFESSOR ALLAN WESTCOTT, U. S. Naval Academy

POLAND AND RUSSIA

SECRETARY COLBY STATES AMERICAN POLICY.—In the form of a note to the Italian Ambassador, Secretary of State Colby issued on August 10 an important note outlining the attitude of the United States regarding the Polish-Russian situation. The note stated: (1) that the United States Government believed in a free Polish state and stood unalterably for Poland's political and territorial integrity; (2) that while not intending to put obstacles in the way of peace negotiations between Russia and Poland, it would not participate in a general European conference on the question, for such a conference would involve "two results from both of which this country strongly recoils, viz.: the recognition of the Bolshevist régime and a settlement of the Russian problem almost inevitably upon the basis of a dismemberment of Russia."

The note continuing reiterated the gratitude of the United States to the Russian people and reviewed the historic friendly feeling between the two nations. It pointed out that America had insisted upon recognition of the rights of Russia in settlement of problems in both the Near and the Far East. The latter part of the note consisted of an arraignment of the Soviet Government of Russia, in part as follows:

> It is not possible for the Government of the United States to recognize the present rulers of Russia as a government with which the relations common to friendly governments can be maintained. This conviction has nothing to do with any particular political or social structure which the Russian people themselves may see fit to embrace. It rests upon a wholly different set of facts. These facts, which none disputes, have convinced the Government of the United States, against its will, that the existing régime in Russia is based upon the negation of every principle of honor and good faith, and every usage and convention, underlying the whole structure of international law, the negation, in short, of every principle upon which it is possible to base harmonious and trustful relations, whether of nations or of individuals.
>
> The responsible leaders of the régime have frequently and openly boasted that they are willing to sign agreements and undertakings with foreign powers while not having the slightest intention of observing such undertakings of carrying out such agreements. This attitude of disregard of obligations voluntarily entered into, they base upon the theory that no compact or agreement made with a non-Bolshevist government can have any moral force for them. They have not only avowed this as a doctrine, but have exemplified it in practice.

Indeed, upon numerous occasions the responsible spokesmen of this power, and its official agencies, have declared that it is their understanding that the very existence of Bolshevism in Russia, the maintenance of their own rule, depends, and must continue to depend, upon the occurrence of revolutions in all other great civilized nations, including the United States, which will overthrow and destroy their governments and set up Bolshevist rule in their stead. They have made it quite plain that they intend to use every means, including, of course, diplomatic agencies, to promote such revolutionary movements in other countries.

It is true that they have in various ways expressed their willingness to give "assurance," and "guarantees" that they will not abuse the privileges and immunities of diplomatic agencies by using them for this purpose. In view of their own declarations, already referred to, such assurances and guarantees cannot be very seriously regarded.

Moreover, it is within the knowledge of the Government of the United States that the Bolshevist Government is itself subject to the control of a political faction with extensive international ramifications through the Third Internationale, and that this body, which is heavily subsidized by the Bolshevist Government from the public revenues of Russia, has for its openly avowed aim the promotion of Bolshevist revolutions throughout the world. The leaders of the Bolsheviki have boasted that their promises of non-interference with other nations would in no wise bind the agents of this body.

There is no room for reasonable doubt that such agents would receive the support and protection of any diplomatic agencies the Bolsheviki might have in other countries. Inevitably, therefore, the diplomatic service of the Bolshevist Government would become a channel for intrigues and the propaganda of revolt against the institutions and laws of countries, with which it was at peace, which would be an abuse of friendship to which enlightened governments cannot subject themselves.

In the view of this Government, there cannot be any common ground upon which it can stand with a power whose conceptions of international relations are so entirely alien to its own, so utterly repugnant to its moral sense. There can be no mutual confidence or trust, no respect even, if pledges are to be given and agreements made with a cynical repudiation of their obligations already in the mind of one of the parties. We cannot recognize, hold official relations with, or give friendly reception to the agents of a government which is determined and bound to conspire against our institutions; whose diplomats will be the agitators of dangerous revolt; whose spokesmen say that they sign agreements with no intention of keeping them.

SUMMARY

To summarize the position of this Government, I would say, therefore, in response to your Excellency's inquiry, that it would regard with satisfaction a declaration by the allied and associated powers that the territorial integrity and true boundaries of Russia shall be respected. These boundaries should properly include the whole of the former Russian Empire, with the exception of Finland proper, ethnic Poland, and such territory as may by agreement form a part of the Armenian State.

The aspirations of these nations for independence are legitimate. Each was forcibly annexed, and their liberation from oppressive alien rule involves no aggressions against Russia's territorial rights, and has received the sanction of the public opinion of all free peoples. Such a declaration presupposes the withdrawal of all foreign troops from the territory embraced by these boundaries, and in the opinion of this government should be accompanied by the announcement that no trangression by Poland, Finland, or any other power, of the line so drawn and proclaimed will be permitted.

Thus only can the Bolshevist régime be deprived of its false but effective appeal to Russian nationalism and compelled to meet the inevitable challenge of reason and self-respect which the Russian people, secure from invasion and territorial violation, are sure to address to a social philosophy that degrades them and a tyranny that oppresses them.

The policy herein outlined will command the support of this government.

Accept, Excellency, the renewed assurance of my highest consideration.

BAINBRIDGE COLBY.

FRANCE CONCURS IN AMERICAN POLICY.—Immediately upon the publication of Secretary Colby's note, the French Government sent a message declaring the French and American Policies "entirely in accord." Premier Millerand stated that France also believed in a free Poland and a United Russia, and that it was with these objects in view that France objected to all negotiations with the Bolsheviki and recognized General Wrangel's opposition movement in southern Russia.

WARNS POLAND AGAINST AGGRESSION.—On August 21 the American Government directed a friendly warning to Poland against aggressive warfare. It was stated at the same time by Washington officials that Great Britain, France and Italy had advised Poland to the same effect. The note follows in part:

The United States applauds the steadfast gallantry of the Polish Army in its defense of Warsaw and is sympathetic with all necessary measures which Poland may take to preserve its political and territorial integrity. This Government, however, urges that every reasonable effort be made to terminate the present bloodshed. It could not approve of the adoption of an offensive war program against Russia by the Polish Government.

The American Government is of the opinion that the Polish advance into Russia tended to create a national sentiment in that country which ignored the tyranny and oppression from which the people suffer and afforded an undeserved support to the Bolshevist régime, which enabled its leaders to embark upon the invasion of Polish territory.

To prevent a recurrence of the present situation the United States Government believes that the Polish Government might well take the opportunity afforded by the favorable turn of events to declare its intention to abstain from any aggressions against Russian territorial integrity; to state that its policy is not directed against the restoration of a strong and united Russia, and that pending a direct agreement as to its Eastern frontier, Poland will remain within the boundary indicated by the Peace Conference.

POLAND OBJECTS TO LINE SET BY ALLIES.—In its reply to Secretary Colby's note, the Polish Government on August 31 expressed certain objections to the so-called "ethnographic frontier" indicated by the Peace Conference, and more definitely laid down by the British Foreign Minister, Lord Curzon, in a note of July 20. The objections were chiefly based on the weakness of the line from a military point of view.

POLISH-RUSSIAN NEGOTIATIONS ABORTIVE.—On August 16 Polish and Russian delegates met at Minsk to reopen negotiations for peace. In spite of the collapse of the Russian offensive, the Soviet delegates refused to modify their terms. After futile discussions the conference ended on

August 25 with Poland's practically complete rejections of the Russian proposals.

Poland's reply to the peace terms presented by the Russian Soviet delegation amounts to a flat rejection, says *The Manchester Guardian* Minsk correspondent.

"Out of the fifteen Russian demands, only one, that relative to demobilization, is accepted, and that only on condition that Russia will take a similar course—that is to say, Russia must demobilize at the same time Poland disbands her forces.

"The terms relative to disarmament, the closing of munitions plants and the delivery of munitions to Russia by Poland are indignantly rejected.

"Bolshevist terms relative to a Polish workers' militia and control by the Russians of the railway line from the Bialystok southward are declared beyond discussion. The boundary line between Poland and Russia, as laid down by Earl Curzon, British Secretary of State for Foreign Affairs, is declared unacceptable, as it involves a third partition of Poland."

FURTHER NEGOTIATIONS AT RIGA.—In spite of the failure of the Minsk conference, both Russia and Poland agreed that negotiations should continue, and accepted the port of Riga, in Latvia, as the location for further discussions. It was expected that the delegates would meet at Riga about the middle of September, to consider Poland's counter-proposals.

BRITISH EFFORTS TO AID POLAND.—On August 10 Premier Lloyd George addressed Parliament at length on the Russian situation, reviewing the policy of the government and seeking to justify its efforts to reestablish trade with Russia, and at the same time secure a peaceful settlement of the Russian Polish problem acceptable to Great Britain and the rest of Europe.

Prior to and throughout the Minsk negotiations, Great Britain brought pressure to bear on Russia with this end in view. Both to Poland and Russia, Great Britain proposed the frontier suggested in the Versailles Treaty and stated in Lord Curzon's note of July 20.

On August 23 the Italian and British governments sent a protest through the Russian agents in London declaring that the terms submitted by the Soviet Government to Poland were not in accordance with those previously agreed upon as acceptable to the Allied Powers, and stating that unless these terms were adhered to Poland would be given all possible assistance in her defense. In particular, objection was made to the Russian requirement that Poland should arm 60,000 workers, as a "civic militia."

To this note M. Tchitcherin, the Soviet Foreign Minister, replied on August 26, agreeing to drop the "civic militia," asserting his willingness to continue negotiations, and arguing at length on the merits of the Soviet form of government.

BRITISH LABOR OPPOSES RUSSIAN WAR.—London, Saturday, Aug. 14.—British organized labor yesterday issued what was virtually an ultimatum to the government.

Practically all of the labor and trades union executives in the country have agreed to hand over their powers to the Council of Action, which was authorized to call for any and every form of withdrawal of labor which circumstances may require in order to secure a guarantee against military

or naval operations against Russia, withdrawal of the Russian blockade and recognition of the Soviet Government.

The gravity of the step was then raised by J. H. Thomas, M. P. In moving one of the principal resolutions he said these resolutions "do not mean a mere strike. They mean a challenge to the whole constitution of the country."—*N. Y. Times*, Aug. 14, 1920.

GERMANY STAYS NEUTRAL.—Berlin, Sept. 1 (Associated Press).—Dr. Walter Simons, the Foreign Minister, addressing the Reichstag Foreign Affairs Committee to-day, declared he had been urged to collaborate with the Russian Bolsheviki against the Western powers as a means of breaking the bonds imposed by the Treaty of Versailles but that after mature reflection he had rejected this course.

"If we had followed these exhortations," said the Foreign Minister, "Germany would immediately have become a theatre of war. Furthermore, the disastrous consequences which Bolshevism might be expected to bring with it would have fallen with double force upon Germany."

Dr. Simons said proposals also have been made that Germany co-operate with the Western powers against Russia, which he considered an equally impossible course.

"No power at war with Soviet Russia," the Foreign Minister added, "need count upon our support."

FRANCE RECOGNIZES WRANGEL.—Paris, Aug. 11 (Associated Press).—The French Government has decided to recognize General Baron Peter Wrangel as head of the de facto Government of South Russia. In making this announcement the Ministry of Foreign Affairs said this recognition implied rendering General Wrangel all possible military assistance.

France will send a high commissioner to Sebastopol immediately, the Foreign Office stated.

Two reasons were given by the Foreign Office for recognizing General Wrangel. The first was his promise to assume all the obligations of the former Russian Government. The second was his promise to give Russia a democratic government.

POLAND'S QUARREL WITH LATVIA.—London, Sept. 7.—The Polish Government has addressed an appeal to the League of Nations requesting its mediation in the Polish-Lithuanian dispute, and the League is considering it.

Unless an improvement occurs in the situation Poland will be compelled to declare war on Lithuania, the appeal states, and it charges that an unprovoked attack had been made on the Polish troops by Lithuanian forces.

The Polish demand is, the note indicates, that the Lithuanian troops evacuate Polish territory within a few days.

Paris, Sept. 7.—The Polish note to the League of Nations asking it to mediate in the Polish-Lithuanian controversy says that while the Polish armies were retreating before the Russian Soviet forces the Lithuanian government concluded an agreement with the Soviet government at Moscow authorizing the Soviet Army to make use of Lithuanian territory for its passage and the establishment of a military base. This, the note points out, was a breach of neutrality. The note continues:

"Later when the Polish armies were forced to withdraw from ethnographic Polish territory as awarded Poland by the Supreme Council on Dec. 8, 1919, Lithuanian troops occupied the evacuated territory and committed excesses toward the populations remaining faithful to Poland.

"When the Bolshevist inasion was repulsed the Polish Army reoccupied Suwalki and the Lithuanian Government sent a note to the Polish Government declaring it did not recognize the frontier as fixed by the Supreme Council and asking the Poles to retire behind the line of Grajevo-Augustowo."

LEAGUE OF NATIONS

PLAN OF LEAGUE INTERNATIONAL COURT.—News reports of August 27 contained an outline of the plan for a Court of International Justice as made by the Jurist's Advisory Committee, on which Mr. Elihu Root was the American delegate, and which was in session during the summer at The Hague. Interest in this plan has been increased by the fact that, though the court is intended as an adjunct of the League of Nations, it has been suggested that the Republican Party in the United States, if successful in the elections, would favor it as a substitute for the League itself.

The plan outlined by the Jurists' Advisory Committee of the Council of the League of Nations was drafted at The Hague in the period between June 16 and July 24. It proved for a continuance of the present Permanent Court of Arbitral Justice and for the establishment of a Permanent Court of International Justice, directed to be formed by the covenant of the League of Nations.

The Permanent Court of International Justice is to consist of eleven judges and four alternate judges. These are to serve for nine years. The court is to sit permanently at The Hague, the purpose of the permanent sitting being that the tribunal shall always be ready to determine causes arising between governments where questions strictly of a legal nature are concerned.

The Permanent Court of Arbitral Justice is to be continued as a body to arbitrate disputes between nations.

The judges of the Permanent Court of Arbitral Justice are to nominate the judges of the Permanent Court of International Justice, whose sittings shall also be at The Hague.

In the selection of judges for the new court, the jurists of each nation who are members of the Court of Arbitral Justice are to form groups, each group to choose not more than six candidates for recommendation to the League of Nations. Not more than two of the six candidates of each nation may be citizens of that nation.

In selecting its six candidates each national group in the present Permanent Court is expected to consult with the highest legal authorities of its own country, including societies devoted to the application and interpretation of international law.

In the case of the United States the members of the American group in the present Hague tribunal would consult, under the terms of the plan submitted, with the United States Supreme Court and probably with the American International Law Society and the American Bar Association.

The International Court of Justice is always to be open for adjudicating cases.

The court is to have the right to compel nations to accept adjudication within certain limitations defining the character of the cases to be adjudicated.

The decisions of the new court are to be founded solely on law and on fact, and the members of the court must not compromise.

To overcome the sensibilities of the governments that the court might infringe upon their sovereignty in undertaking to adjust disputes, the Committee of Jurists followed the definition of proper cases for adjudication laid down in Article 13 of the Covenant of the League of Nations. This definition goes a considerable distance beyond prior definitions of what are to be considered justiciable international cases. The appropriate paragraph of Article 13 reads as follows:

"Disputes as to the interpretation of a treaty, as to any question of international law, as to the existence of any fact which it established would constitute a breach of any international obligation, or as to the extent and

nature of the reparation to be made for any such breach, are declared to be among those which are generally suitable for submission to arbitration."

This provision avoids the danger that nations would reject the assumption by the court of the right to adjudicate compulsorily all or nearly all questions of differences between nations.

Any government will have the privilege of bringing to the court any legal question that bears upon any of the matters defined in Article 13 of the covenant. If the government made defendant fails to appear, the court will hear the cause and render its judgment.

In determining cases, the court will be empowered to be guided by international agreements to which the nations involved are parties or which they have accepted; recognized practices accepted as international law; general legal principles that have been recognized by civilized nations; judicial decisions accepted by eminent jurists of various nations.

If a nation involved in a dispute before the court is represented on the court this will not exclude that judge from participating in the case.

If a nation which is a party to a dispute is not represented on the court it will have the privilege of naming a member of the court to sit in the adjudication of the case as a special judge for the occasion.

If any nation not a member of the League of Nations wishes to have a case adjudicated before the court it could qualify for that purpose by accepting the obligations defined in Article XVII of the League covenant and by paying its proportional portion of the expenses of the adjudication.—*N. Y. Times*, Aug. 28, 1920.

The plan does not provide the means of enforcing the decrees of the court. That means is found in the provisions of the League of Nations covenant for concerted action to bring a recalcitrant nation to accept the dictates of the League.

IRELAND

LLOYD GEORGE'S TERMS TO IRELAND.—London, Aug. 16.—In reply to a question in the House of Commons to-day, Premier Lloyd George again announced the willingness of the government to discuss with any representatives of Irish opinion any proposals for a settlement.

The Premier said such discussion would be subject to three conditions, as follows:

First, that the six counties of Northern Ulster must be treated separately; second, that there must be no secession directly or indirectly of any part of Ireland from the United Kingdom, and third, "We cannot agree to anything that would involve any detraction from the security of these islands or of their safety in case of war."

The Sinn Feiners would not be ruled out if they were prepared to accept these conditions, Premier Lloyd George said.

LLOYD GEORGE OBDURATE AGAINST HUNGER STRIKERS.—September 7 was the twenty-eighth day since the eleven hunger strikers in Cork jail refused food. Terence MacSwiney, Mayor of Cork, the chief of the political offenders was at that time at the point of death.

Lucerne, Sept. 5 (Associated Press).—Premier Lloyd George of Great Britain has replied in the negative to the message of Mayor Hylan of New York City, which urged the Premier to release Mayor MacSwiney of Cork from prison. The Premier in his reply, dispatched yesterday, stated politely but firmly that he could not interfere with the course of justice and law.—*N. Y. Times*, Sept. 6, 1920.

ITALY

WORKMEN SEIZE FACTORIES.—Rome, Sept. 7.—The employers in metal working factories which have been seized by workmen in the present contest over conditions in this industry have received five days in which to comply with the workingmen's demands, according to a resolution passed by the Socialist members of the General Federation of Labor. If the employers do not yield, a rapid movement toward general nationalization is threatened. So far the manufacturers are persisting in their decision not to enter into direct negotiations with the workers before the latter evacuate the factories.

It is estimated that 400 of the largest metal works in Italy have been occupied by mechanics and workers, and the movement is still expanding, threatening to extend to the extreme southern end of the peninsula. Elaborate steps have been taken by the government to preserve order during the period when a general offensive against all industries is threatened.—*N. Y. Times*, Sept. 8, 1920.

NEAR EAST

ENGLAND FREES EGYPT.—London despatches of August 23 carried definite information regarding Great Britain's decision to grant Egypt virtual independence.

The decision according to the London *Times*, resulted from recent conversations here between the Viscount Milner's mission, which recently visited Egypt, and an Egyptian delegation headed by Said Zagloul Pasha, former Minister of Justice.

Among the fundamental points of the agreement are:

"Egypt will recognize Great Britain's privileged position in the valley of the Nile and agree, in case of war, to afford every facility for access to Egyptian territory. Great Britain will maintain a garrison in Egypt in the Canal zone. Egypt regains control of foreign relations, subject to her not making treaties contrary to British policy, and will have the right to maintain diplomatic representatives abroad. Capitulations will be abolished."

A BALKAN COALITION.—To protect themselves primarily against the reactionary government of Hungary, and also against Russia or other powers inimical to the nearly formed Balkan nations, the Czechoslovak, Jugoslav, and Roumanian governments have formed a defensive alliance which has been given the name of the "little entente." Vienna reports state that British and French officials do not view with entire approval this action of the Balkan States in coming to an understanding independently of the chief European powers.

GREEK PREMIER WOUNDED.—On the night of August 12, Premier Venizelos of Greece was shot at and wounded in the shoulder and thigh while entering the Lyon railway station in Paris. His assailants were two Greek officers, adherents of the former King Constantine. M. Venizelos's recovery was later reported.

At the time of the attack the Premier was returning to Greece after the signing of the Turkish Treaty at Sévres on August 10. This treaty marked a triumph of Venizelos and of Greek policy, its terms more than doubling the 30,000 square miles of Greece and quadrupling its former population of 3,000,000.

BULGARIAN TREATY RATIFIED.—Paris, Aug. 9.—The Peace Treaty with Bulgaria was made formally effective by the exchange of ratifications to-day among the powers which are parties to it.

The treaty was signed at Neuilly on November 27, 1919, and was ratified by the Bulgarian Sobranje January 12 of this year. France's ratification of the treaty was completed by the favorable action of her Senate on July 31.

MEXICO

TERMS FOR RECOGNITION.—On August 17 the Mexican Government published a message to President de la Huerta from Señor Calderon, the Mexican High Commissioner in Washington, purporting to present the terms upon which the United States would recognize the new Mexican Government. These terms were:

First—That North American lives and property be respected.

Second—That indemnities be paid to foreigners who suffered during the revolution.

Third—That the Carranza decrees which are found to be confiscatory be derogated.

Washington officials later stated that these terms were only "a few of the conditions announced," that the United States wanted performance more than promises, and that it would delay recognition until the new government proved its strength and intentions.

OBREGON ELECTED PRESIDENT.—Early announcements of the elections held in Mexico on September 5 assured the election of General Obregon as President.

PROTEST AGAINST OIL POLICY.—Washington, Sept. 7.—It was officially made known at the State Department to-day that instructions were sent to the American Embassy in Mexico City, about three weeks ago, to notify the Mexican Government that the United States regarded the operation of the "denouncement law" and the Federal zone law in the oil fields as an infringement of the rights of Americans under international law.

It was said at the department to-day that no report on the delivery of these warnings to the Mexican Government had been received from the embassy, and the report that Provisional President de la Huerta had refused to receive the communication because it was couched in "impossible" language is discredited by the officials. It was said that if such a situation arose Chargé d'Affaires Summerlin would immediately communicate the facts to the department.—*N. Y. Times*, Sept. 8, 1920.

JAPAN

ANGLO-JAPANESE ALLIANCE.—It was learned on September 3 that the American, British, and Japanese governments were engaged in informal conversations respecting the terms of the Anglo-Japanese Treaty, which was renewed in July for only one year. There is no suggestion that the United States will become a third party to the treaty, but it is evident that a better understanding among the three powers regarding their interlocking interest in the Far East will lessen the tension in that quarter. There is need in particular of a more definite understanding regarding Japan's "special interests" in China, which were recognized in the Lansing-Ishii Agreement,

but which the United States refuses to regard as justifying Japan in establishing a "Monroe Doctrine" for the East.

On the same date Secretary Colby and Governor Stephens of California conferred regarding the Japanese situation. California in November will cast a referendum vote on the question of more drastic legislation against Japanese land holding.

REVIEW OF BOOKS
ON
SUBJECTS OF INTERNATIONAL AFFAIRS

"Marine Engineers' Handbook."—Sterling. 1450 pages, fully illustrated. Index of 28 pages. (Published by McGraw-Hill Book Company, Inc., New York.)

This handbook, as its preface states, is compiled for the use of operating and designing engineers and of students.

It will supply the need long felt by Marine Engineers for a handbook covering every phase of marine engineering.

It is divided into fifteen sections with subdivisions.

Every section being prepared by a recognized expert gives the best practice and the most approved modern theory of marine engineering.

It includes: Section 1. Mathematical Tables and Formulæ, Mechanics of Rigid Bodies; Section 2. Non-Ferrous Metals and Alloys, Iron and Steel, Oxy-Acetylene Welding, The Thermit Welding Process, Heat; Section 3. Coal, Oil Fuel, Combustion Oil Fuel Burning; Section 4. Boilers; Section 5. Turbines, Mechanical Reduction Gears; Section 6. Reciprocating Engines; Section 7. Marine Diesel Engines; Section 8. Vacuum and Condensers; Section 9. Ships Forms and Powering, Screw Propellers; Section 10. Evaporators and Distillers, Oil Coolers and Feed Water Heaters, Centrifugal Pumps, Reciprocating Pumps, Air Compressors, Centrifugal Fans, Heating and Ventilating, Deck Machinery; Section 11. Piping, Valves and Fittings, Reducing Valves and Pumps, Governors, Steam Traps, Pipe Covering and Lagging; Section 12. Marine Electrical Installation; Section 13. Lubrication and Lubricants; Section 14. Measuring Horsepower of Marine Engines; Section 15. Tests, Trials, Inspections, Classification Societies.

The book is concluded with a very valuable chapter giving the names and addresses, and duties or aims of societies, associations and commissions which have various functions utilized by Marine Engineers in planning and executing Marine Engineering work.

This handbook is a valuable work and deserves a permanent place in the library of all marine engineers, whether designer, operator or students. It also will supply much valuable information to other engineers.

W. L. F.

"Forty Years in the Pacific." By Frank Coffee. 350 pages. (Published by the Oceanic Publishing Company.)

An account of wanderings in the Pacific covering many years, told in a wandering style. The author tells of many voyages and deals more or less fully with the description, physical geography, history and customs of

the places visited with deviations into personalities and "that reminds me's."

There is much information of value to the prospective traveler by sea, such as time, day's run, oil burning, amusements, wireless, cables and even advice as to the prevention of seasickness. Unfortunately the information regarding the little known spots such as Fiji, Yap, Solomons, is meager, being mostly abridged from other works.

The author begins with a history of navigation in the Pacific, then describes voyages to Auckland, Sidney, Canton, the Philippines, Honkong, Japan Hawaiian Islands, Norfolk, Lord Howe and Christmas Islands, the latter the scene of the wreck of the *Aeon* upon which were the wives of Capt. W. K. Reddle and Capt. B. R. Patrick, Ch. C. U. S. N. Then follow New Caledonia, New Hebrides, British Solomon Islands, Gilbert Islands, Dutch New Guinea, Tahiti, Tonga Samoan Islands, Fiji, New Zealand, with information upon Polynesian pastimes, volcanoes, copra, sugar and other products, favorite forms of "Tipple," missionaries, fish stories, Then follow miscellaneous short articles upon wireless, Alaska and Yukon telegraph, submarine signals, oil and fuel used at sea, difference of time, rule of the road at sea, classification and tonnage. Alaska and Australia are dealt with quite fully, and the Pelew Caroline, and Marshall Islands and German New Guinea briefly. The rest of the book is taken up with "random notes."

This work should be of value in ship's libraries, though much of it is of little value to sea-going people. It is of great value to the prospective traveler in the Pacific.

B. C. A.

"Navigation by Position Lines, or Marcq Saint-Hilaire, Method:" By J. W. Saul.

This book is a distinct contribution to the further spread of the knowledge of a method of navigation, which is unquestionably the best so far found. This method, which is a development of the old Sumner position line, has been practically standard in the United States Navy for several years.

The haversine formula advocated by the author is the one most used, but in a somewhat different form, although the sine-cosine formula, the versine formula, or the numerous types of spherical traverse tables may be utilized.

Using the author's abbreviations (ref. page 5) the following is the formula recommended by both Bowditch and Muir:

$$\text{Lhav}\,\theta = \text{Lhav}\,\text{P} + \text{Lcos lat} + \text{Lcos dec.}$$

(The (-20) is only to adjust the logarithmic characteristic.)

$$\text{Nathav zen. dist.} = \text{Nathav}\,\theta + \text{Nathav (lat} \sim \text{dec.)}$$

It will be noted that the use of this formula requires less subtraction, and therefore reduces the probability of error. From the zenith distance, by the above, the "computed altitude" is found and this combined with

the "true altitude," gives the "altitude difference" or the "intercept," which is the number of miles, the position line must be removed from the dead reckoning position, toward the body if the true altitude is greater, and away if the true altitude is less.

It is to be regretted that the author did not include the formula for the great circle course, as well as the distance, as it would have made the book more complete.

In another edition, the book should be more carefully gone over, as there are some slight errors in the statements of the problems and their solutions which do not however affect the principles involved.

A. M. R. A.

"Sea Power in the World War." By Captain R. Bernotti, Italian Navy.

This work consists of a review of the World War in order to draw the lessons in tactics, strategy and organization that actual experience has tested out and shown to be successful.

Captain Bernotti makes a brief review of the naval forces of the world powers, leading up to the war and the political attitude of these powers, and development of their naval strength in consequence of that attitude.

He handles the strategy under the three geographic groups of Baltic and North seas, Mediterranean and Black seas and the general operations on the High Seas, including Tsing Tau, the Pacific and the South Atlantic.

A special chapter is given to the submarine warfare against the merchant service and another to the overseas expeditions.

Under naval tactics after a brief review of the changes since Japanese-Russian War showing the great development in fire control, he reviews the various cruiser actions and finally gives a chapter on the Battle of Jutland. This is a very interesting chapter, as well as the two following ones in which he shows the effect that the long range torpedo from the destroyer, and the short range torpedo of the submarine have had on the battleship tactics. The general subject of approach, and the need for formations for quick deployment are also discussed.

In conclusion Captain Bernotti emphasizes the need for underwater protection, giving a table of losses of naval vessels during the war in which only 17 per cent was due to gunfire, the torpedo and the mine accounting for the rest.

R. H. J.